What do critical care nurses require from a clinical information system: is it possible for a system to meet these needs?

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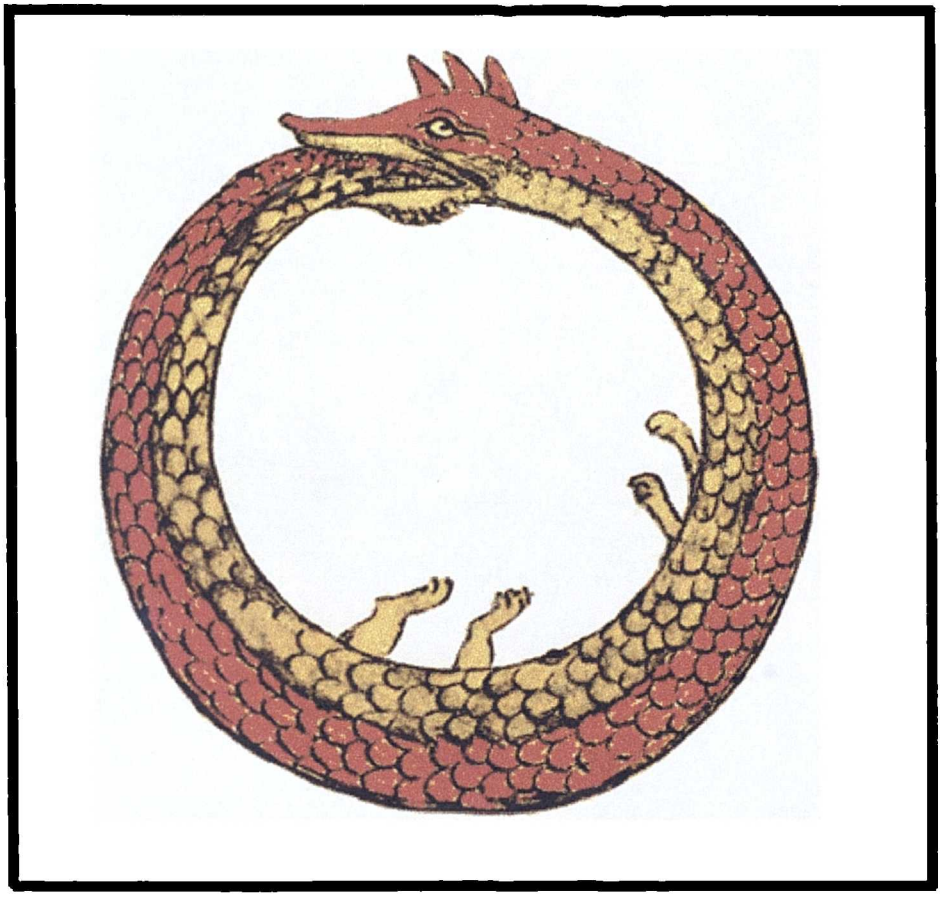
Volume one: The project



Frontispiece: The serpent Ouroboros. Detail from a mediaeval painting.

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Abbreviations

CAIT	Clinically Applied Information Technology
CIS	Clinical Information System
CND	Clerical Nursing Duties
CT	Computerised Tomography
DNC	Direct Nursing Care
ECG	Electro Cardio-graph
Glenfield	Glenfield Hospital, Leicester, England
HIS	Hospital Information System
IA	Information Activities
INC	Intermittent Nursing Care
IT	Information Technology
John Radcliffe	The John Radcliffe Hospital, Oxford, England
KW	Kruskal Wallis
LAN	Local Area Network
LGH	Leicester General Hospital, Leicester, England
MW	Mann Whitney
NHS	National Health Service
NND	Non Nursing Duties
PA	Patient Assessment
SPSS	Statistical Package for the Social Sciences
TO	Time Out
TNC	Technical Nursing Care
UK	United Kingdom
UKCC	United Kingdom Central Council for Nursing, Midwifery and Health Visiting

Abstract

Much has been claimed for the use of computerised information systems (CIS) within critical care, however little has been proven. The main users of these systems will be bedside nurses caring for their patients, yet no research has been generated by these nurses and the studies which exist are generally unsatisfactory, often relying solely upon inappropriate quantitative research tools. To explore the impact of a CIS, an extended case study format was proposed using both quantitative and qualitative research tools. Within this framework three distinct phases of research were undertaken, moving from inductive to deductive enquiry.

Firstly, a set of interviews were conducted at a critical care unit where it was expected that a CIS would shortly be implemented. Thus the nurses were aware of the issues surrounding a CIS and had expectations of ways in which the system might change the way they worked. This set of data showed that the nurses were likely to accept any implementation which supported the ways in which they delivered their nursing care. These activities were identified as their 'primary aims' and were demonstrated to be radically different from the issues addressed within the literature. The second research phase again used interviews to explore the opinions of a group of nurses who had used a CIS, but no longer did so. The data from this phase triangulated very clearly with the first, but the definition of the primary aims was enlarged to include a second dimension, whereby data management was used to inform patient care.

Lastly, having identified the primary aims, the findings from the first two phases were used to conduct a comparative analysis between sites which use a CIS and those which rely on conventional charting methods. Convincing quantitative and qualitative data were obtained which showed that current CIS can indeed support the nurses' primary aims and showed that the primary aims contain the two dimensions previously identified.

However although computerisation of patient information is glamorous, it was also identified that a thorough review and improvement of conventional manual charting could also result in a qualitatively similar enhancement to the ways in which the nurses worked.

Introduction

'It always comes as a shock to see the person you love lying unconscious on a hospital bed, surrounded by monitors and medical machinery, and hearing the rasping breath of a ventilator blowing air into their lungs ...above each patient's bed is a monitor, with several wavy lines of different colours constantly flickering across the screen. Each line records the measurements we need to see how the patient is progressing: arterial blood pressure, heart rate, pressure inside the brain and a whole host of others which may be tailored to a particular case... electrically controlled drips and motor driven syringe pumps also vie for space. Even the bed may be temperature controlled. It is a high technology response to illness, providing us with a constant flow of information on the rapidly changing state of a critically ill patient.'
(Yeomans and Sleator 1995 p3)

Introduction: what this work is and what it is not

Nurses relieve suffering. Rightly, nurses are fiercely proud of this. This thesis will look at one specific group of nurses, those working within critical care units. One possible resource for these nurses is the ability of computerised systems to support their patient management and data collection. This is the main topic of this work.

In general, this work will use the term Information Technology (IT) to refer to the contribution that electronic systems can make in the accession, handling, and recording of patient and other clinical data. The term therefore will subsume a whole set of technical terms such as computerisation, communications technology, and informatics. Although the validity of IT as a term is being questioned (Anthony 2001) it remains useful as a broad generic and remains in common use.

Within the critical care environment, a significant amount of IT is already available and in use. However its presence is often not obvious. In much the same way that it is not necessary to be a mechanic in order to drive a car nor

be a plumber to take a bath, nurses may make expert use of complex equipment which incorporate IT, without being knowledgeable about the technology that allows it to work. For example monitor readouts and alarm systems are used as tools in the day to day provision of nursing care.

Within the last ten to fifteen years, computerised systems have been developed which have the potential to change radically the way that critical care nurses work. These have largely been referred to as both Clinical Information Systems (CIS) and Patient Data Management Systems. Although the terms are essentially synonymous, CIS will be used as it is more commonly reported within the recent literature. Perhaps the single criterion which defines CIS is the ability to integrate all of the disparate IT sources together, so that instead of there being a number of stand-alone pieces of equipment, the acquisition, handling and recording of data can become unified.

This is a research project which intends to explore the potential and actual impact of these systems on nurses within critical care. What it is not, is an exploration of the systems themselves, except where this knowledge directly impacts upon nurses or their clients. In summary this is a project about nurses, it is not a project about computers.

Nursing roles within critical care

In order to explore the impact which a CIS can have within the clinical setting, it is first necessary to explore the ways in which nurses work. Unfortunately, it is difficult to pin down exactly what a nurse is or does. Pragmatically, in the United Kingdom (UK), until 2002, by which time all the fieldwork for this project had been undertaken nurses were people who, through a programme of study, had satisfied the practical and theoretical requirements of one of the national boards of nursing and were registered with the United Kingdom Central Council (UKCC) for Nursing, Midwifery and Health Visiting. As such they were bound to act within a code of professional conduct (UKCC 1992a) which required them at all times to safeguard and promote the interests of their clients, serve the interests of society, justify professional trust and confidence and uphold and enhance the good reputation of the profession.

More theoretical definitions of nursing range from the platitudinous *'we help people'* (Ellis 1994 p20) to the impenetrable *'nursing is a science and the application of knowledge from that science to the practice of nursing'* (Andrews and Roy 1986 p5). Most people will have an idea in their minds as to what a nurse is and does, but it is likely to be a stereotype or simply inaccurate. Even Florence Nightingale could not define the term clearly. In 1859 she wrote

> *'it has been said that every woman makes a good nurse. I believe on the contrary that the very elements of nursing are all but unknown'* (Nightingale 1992 p16).

To give care has been described as a central, primary or core concept in nursing, but a definition of care remains at least as elusive as that of nursing (Cody 1998). Morse et al (1990) suggest that care is an emotional or feeling response, a moral imperative, a therapeutic intervention and an interpersonal interaction. Caring is considered a universal phenomenon with nurses as the providers of care, in the business of creating the right environment in which others can grow (Leininger 1998; Kitson 1987). To contribute to a better understanding of the meaning of nursing it is necessary to focus on the purpose of care. Nursing care that does not meet the requirements of patients cannot be viewed as good nursing care. Milburn et al (1995) suggest that the most important focus is the nurse/patient relationship, with patients specifically wanting nurses who can demonstrate that they understand their needs, who communicate with them, are capable of 'being with' them and giving time when needed, and who can anticipate needs and provide assistance when necessary. Caring is therefore the essential element in all aspects of nursing. Any aspect of IT which can support the nurses in fulfilling these roles is therefore likely to be of benefit to the profession, its practitioners and its clients.

In the late 1970s, to support the progression of nursing towards becoming an independent profession, models of nursing were introduced to underpin the practical skills at the centre of nursing (King 1981; Neuman 1982; Gordon 1987). They share a common problem solving approach known as the nursing process, which shows nurses how to organise their work. It is based

upon four components: assessment of the patient, planning of care, the implementation of care and the evaluation of the care that has been given. However, on its own, the nursing process is inadequate. For example, it does not tell nurses *what* to assess. Ellis (1994) suggests that, historically at least, on its own the nursing process resulted in nurses using the only model they were familiar with: the medical model. Extensive use of the medical model has been seen as being limiting to the development of nursing as an independent profession. To resolve this limitation, a large number of nursing models have been developed and instituted. These have been classified as being based upon needs, interactions and outcome theories (Meleis 1985). To follow their development can be illuminating, as it parallels the ways, over time, that nurses have sought to redefine their roles.

The earliest models are classified by Meleis (1985) as being needs based. According to these models, when a need is unfilled and when a person is unable to fulfil his or her needs, nursing care is required. Nurses therefore function by helping patients meet their needs. Needs models are characterised by a focus on problems, nursing functions and an orientation that begins to move away from medical towards a more client focussed approach (Millar and Burnard 1994). However, they are reductionist in approach: a human being is seen as a set of needs, a nurse as a set of functions. This approach is still close to the medical point of view, although as Millar and Burnard (1994) observe, it can include emotional needs, such as belonging and self esteem.

A second group of nurse theorists developed models based upon transactionalism. These models focussed on the process of care and the interaction between the patient and nurse. Meleis (1985) argued that these models have been very influential, because they have provided some of the most significant insights into what makes nursing a unique profession. They theorise that nursing is an interpersonal process between a person who needs help and one who can give help, that giving of care is not a mechanistic act, that the perception of the patient is important and that the nurses' values and subjectivity are important components of the transaction.

The third and final group used outcome theories. They described the main focus of nursing care as the re-establishment of balance and stability between the individual and the environment. They are based upon systems, adaptation and developmental theories. They can be described as looking at the 'why' of nursing (Millar and Burnard 1994).

These theories illustrate clearly that to define precisely what a nurse is or what a nurse does is a complex procedure. Nursing occupies such a broad remit that in fact it may not be possible. However, each of the three types of nursing theory discussed above can make a contribution and help explore the concepts of nursing which are relevant to this project. The 'need' theorists contend that nurses work to satisfy the needs of their patients. This is readily observable in daily nursing practice, but such an analysis suggests that nursing may be composed of a number of tasks, and this is unsatisfactory, as it gives no idea of uniqueness beyond the aggregate of these tasks. It serves as a description, not a definition, but it does function as a basis for an inventory to identify nursing interactions. This approach has been used in reductionist studies of how critical care nurses work (for examples see Bradshaw et al 1989; Hendrickson et al 1990; Lutheran Hospital 1991; Norrie 1997, discussed in chapter two), and has produced important, if possibly flawed data. Conversely, the interactionists contend that nursing is a process defined between the nurse and patient, and it is only through this process that nursing can be described as becoming client centred and holistic. These are valuable goals, increasingly being seen as major and valuable components of good nursing practice (Ham Ying 1993; French 1995). If a CIS can promote these qualities, it may be seen as an attractive proposition by the nurses who use it.

Lastly, the interactionists contend that the nurse and patient work out their own dynamic within the particular environment they occupy, suggesting that the work of the nurse is context related within their care environment. This is an important point for this project because of the unique pressures evident within the critical care environment. For example, if a CIS can make an improvement in the time management of the nurses, so that more time can be made for supporting their patients, this is likely to be very positively evaluated

(Urschitz et al 1998). A combination of these theories suggests that nursing is composed of actions undertaken by nurses, in conjunction with their clients and is set within a specialised clinical environment. Therefore, the environment within the critical care unit will now be discussed.

Within the critical care unit

Until recently, critically ill patients were treated within 'intensive care units' or 'intensive therapy units.' The development of these dates back to the second world war, where facilities were developed near to battle fronts for the treatment of shock. However, it was during the 1950s that units specialising in assisted ventilation were developed as the result of polio epidemics, which were affecting most of the western world. These units occurred first in Denmark and then spread throughout Europe, North America and elsewhere (Ashworth 1990). By using equipment that had been previously confined to the operating theatre, mortality was greatly reduced for the critically ill patient, especially when this was combined with constant attendance from medical and nursing staff (DOH 2000). Since this time there have been many further advances in patient care, resulting in the capacity within specialised units to support or temporarily replace the failing vital function of most organ systems.

Again, until comparatively recently, it was widely accepted that within intensive care units nurses worked in a one to one ratio with their patients (Pilcher at al 2001). This was a reflection of the dependency of the patients within the area. These patients, because of their extreme illness and vulnerability, could not be left alone at any time and a nurse or other member of the multidisciplinary team had always to be present. Following a highly influential government paper, Comprehensive Critical Care (DOH 2000), a distinction was made between such patients and 'high dependency' patients. A 'high dependency' patient requires an intermediate level of care between that which the ward can offer and the full response of the intensive care unit. They require close monitoring and are at risk of developing acute or chronic single organ failure, but do not require multiple organ support or mechanical ventilation (Department of Health 2000; Pilcher at al 2001). Because of this, instead of 'intensive care', the trend is now towards larger 'critical care' units,

which comprise a mix of 'intensive care' and 'high dependency' patients, allowing a more fluid allocation of staff, determined upon by the needs of the patient's condition. In line with this trend, the term 'critical care' will be used throughout this work to denote clinical areas which care for both categories of patients.

Within a critical care unit at any one time therefore, there will be a mixed population of patients who may require support for their hygiene, nutrition, breathing, pressure areas, circulation, renal function and cardiovascular status. They may also require many medications including intravenous sedating and pain killing drugs. To deliver and monitor these interventions, a large artillery of medical devices has been introduced. In order to use these skilfully and for the full benefit of the patient, critical care nurses have had to expand their roles. Therefore it is reasonable to suggest that there is a co-dependence between the evolution of the technology and the evolution of nursing practice (Berg 2001).

Although many units employ technicians, nurses are directly involved in technology related tasks such as managing bedside machines, recording observations from them and changing the regimes of prescribed drugs. However, authors such as Turnock (1994) and Woodrow (2000) have suggested that the fact that technology provides a valuable means of monitoring and treatment should not allow it to become a substitute for care and that for nursing to retain a patient centred focus, it is the patients themselves and not the machines which must remain central to the nurses' role, an important distinction. Indeed the UKCC anticipated such expansion of roles. They stipulated that any new functions taken on by nurses must be justified as meeting the needs and serving the interests of the patient or client, and must be achieved without compromising or fragmenting existing aspects of professional practice and care (UKCC 1992b).

Therefore technology and IT should support the nurses' caring role, and not supplant it. Technology is a tool which is available to support the care of patients, but to do this, it must be used appropriately and skilfully (McConnell 1990; Turnock 1994).

The contribution of IT

IT was introduced in hospital and health care during the 1970s and 80s. In most countries the first systems did not directly influence nursing care. Initially Hospital Information Systems (HIS) serviced laboratories, radiology and other support departments. The benefit to nursing came indirectly from the systems used by these, as well as administrative departments. Experience of the improved efficiency and effectiveness of these applications increased the interest in the use of IT for directly supporting nursing activities (Pluyter-Wenting 1992). Unfortunately there was also a negative aspect to the introduction of computerised technology and machinery in critical care. In addition to the direct physiological benefits of technologically driven therapies, critically ill patients are at profound psychological risk from the hostile environment that is due, at least in part, to their dependence upon the selfsame technology. For example, Demeyer, as early as 1967, found that patients experienced anxiety as a result of feeling tied down by electrocardiograph (ECG) leads. Anderson (1982) found that subjects were unaware of the purpose of monitoring, believing amongst other things, that ECG leads acted as cardiac pacemakers, or that they measured cardiac output. Therefore apparent sudden changes in heart rate due to artefact could trigger extreme anxiety. In addition, the presence of strange machines and unusual noises are themselves stressful (Asbury 1985). All the technologies contribute noise and will exacerbate sleep deprivation and sensory overload (Dolan 1991). Both these conditions are harmful and contribute to confusion, disorientation and delirium, the so called 'intensive care psychosis' (Roberts 1991; Dyer 1995).

Norrie (1995) suggested that since nurses were exposed to the same environmental factors, they too were at risk of long term stress, which if unrelieved could lead to the phenomenon of burnout. Lloyd-Jones (1994) suggests that the critical care environment *itself* is a stressor. As Hay and Oken (1972 p110) point out

'mistakes are inevitable, but in an environment where every procedure is potentially life saving, any error may be life endangering, hence the critical care nurse lives chronically under a cloud of latent anxiety.'

This condition cannot be conducive to developing nursing, or to optimising patient care. The increasing presence of advanced technology in the clinical environment therefore is a two edged sword: it not only provides physiological support, but also causes stress. Therefore it is important that its application is justified by showing clear benefits to the patients who are treated by it. In addition, the impact of CIS on critical care nurses' practices and work experience within the unit has never been investigated. Nurses in both critical care and other care environments are exposed to a large number of stressors. In the short term, the amount of stress that they are subjected to may be a stimulation, but it is necessary to provide resources in terms of adequate staffing, a good working environment and civilised working practices, so that nurses can work freely to promote their profession (Norrie 1995). CIS could be a valuable contribution to this aim.

Background and aims of this project

The author of this thesis is a lecturer in critical care nursing. Prior to this post he worked as a specialist nurse in intensive care nursing for 10 years. During this time CIS became commercially available. The majority of these applications have taken place in continental Europe and Northern America (Lenz and Metnitz 1995), with only six applications reported in the literature in the UK (Groom and Harris 1990; Lenz and Metnitz 1995; Harmsworth and Still 2002). Since a flurry of reports on early systems (Bradshaw et al 1989; Hendrickson et al 1990; Lutheran Hospital 1991), there has been little published on the development and implementation of CIS specifically within the critical care setting. What has been published is overwhelmingly written by medical staff and originates from North America. Indeed in an initial literature search of 181 articles to explore CIS implementation, only 17 of these could be identified as being written by nurses or as being focussed on nursing and only four originated within the UK.

This raises some interesting issues. Firstly, nurses within a critical care setting are the majority users of bedside equipment (Crewe et al 1987; Bradshaw et al 1989; Hendrickson et al 1990; Lutheran Hospital 1991; Norrie 1997a). This is in direct contrast with the peripatetic nature of consultant rounds and medical interventions. It follows that nurses represent the major user group for CIS in this setting. Despite this, they remain very much the minor players in published work examining the use of CIS.

The research questions

This thesis intends to explore two main research questions relevant to this inequality. These are:

1. What do critical care nurses want from a CIS?
2. Can a CIS meet these needs?

By doing this it aims to satisfy at least one major criterion of good research, that of originality (Phillips and Pugh 1994). It is intended that this focus of study will provide not only an original contribution to knowledge, but also important information which can be used to support future developments and aid the implementation of computerised systems within the intensive and critical care setting, both in the UK and world-wide.

Literature Review

In order to explore the literature surrounding CIS a protocol was drawn up of search terms to be used. The constituents of this are shown in table one and were generated following an informal review of journals relevant to aspects of computerisation within the health care setting, specifically *Information Technology in Nursing*, *Medical Informatics and the Internet in Medicine* and the *International Journal of Clinical Monitoring and Computing*.

These terms were used to explore two data bases, the Cumulative Index to Nursing and Allied Health (CINAHL) and the British Nursing Index (BNI).

Table one: Search strategy used

	Terms used	BNI 1997*	CINAHL 1997*	New items from CINAHL 1997-2002
1	Computer$.	1330	1979	
2	Computer$ and health	343	925	
3	Computer$ and nurs$	167	2126	
4	Computer$ and nurs$ and research	21	337	
5	Intensive care and computer$	24	47	69
6	Critical care and computer$	7	71	55
7	Intensive care and computer$	24	47	69
8	Patient data management system	3	4	0
9	Clinical information system	7	33	58
10	Computer$ and NHS	50	19	83
11	Computer$ and management	289	467	756

*Denotes items published prior to and including September 1997
Note: .tw. suffix used in CINAHL

Of necessity, only English language articles were chosen. Sampling of items contained within terms one through to three, based upon what was available in local university libraries produced a poorly differentiated group of sources, with inclusion of articles relating to a broad remit of information technology, or the use of technology within unrelated clinical areas. In addition, it contained a preponderance of papers based upon reportage and often unsubstantiated

opinion. To address this, term four was formulated, but again the findings were too broad and lacked focus on the clinical setting. Therefore it became clear that a closer focus was required on the clinical environment. Thus items five through to nine were defined. Sampling of these hits was much more productive and these constitute one of the main sources for the literature review. Therefore what was produced at the inauguration of the project in 1997 was a total of 267 references to be explored, giving 181 individual items, once repeated hits had been deleted.

Some other sources were also included. Firstly the researcher in previous published work (Norrie 1997b; Norrie 1999; Norrie 2000 and Norrie and Blackwell 2000) had uncovered a number of relevant studies surrounding CIS implementation and these were also considered for inclusion. Secondly, as the project developed, informal updates of the literature search were undertaken by 'hand-searches' of recent issues of relevant journals including those cited above, a strategy supported by Atkinson et al (2001). Finally the Cochrane Library and the National Institute for Clinical Excellence were explored to identify work within clinical settings which could be influential.

The grey literature

Grey literature is not controlled by commercial publishers. As such it may contain theses, conference proceedings, government and other official documents (New York Academy of Medicine 2003). This means that most grey literature will have had limited, if any, peer review and may contain opinion and unsubstantiated fact. However, some authors maintain that it can be valuable, in particular in containing up to date or provisional research findings (European Association for Grey Literature Exploitation 2003). As a strategy, the use of grey literature was not advocated within this project. This is for two reasons.

Firstly, even casual reading of the published literature surrounding the use of computers within the health care setting reveals much exposition of opinion, but relatively little evidence based upon research. In order to avoid this and produce an unbiased project, there is a clear need to avoid opinion, or at least treat it with caution and to concentrate upon credible research findings. This would potentially be jeopardised by the inclusion of significant amounts of grey literature. Secondly, within the NHS, there is current emphasis from

government in general and the Department of Health in particular on implementing electronic record keeping systems, such as the Electronic Patient Record and Electronic Health Records (Brennan 2000). Because of the impetus behind this and the availability of financial support, there is a possibility for positive bias amongst health care professionals surrounding these innovations. Thus it seems sound to avoid this possible bias by focussing largely on research which can be shown to be of quality and to be extremely cautious in using the grey literature. However, it is also true that health care is a highly politicised field and so some inclusion is probably necessary, especially when discussing the implications of research findings. Therefore, exception will be made if it is appropriate to discuss research findings in the light of government or service initiatives within the NHS, but this limitation will be noted.

Selection criteria

The research degree guidelines for the project specified a thesis of no longer than 80,000 words. Thus a word limit of approximately 20,000 words for the literature review was chosen as an initial target. Within this two necessary items were identified. Firstly, a discussion of what a CIS can do and how they operate was needed to give context and insight to the project. Secondly, the identification of research findings to explore ways in which CIS effect nursing was required to give an evidence base. These will be treated separately.

What are CIS and what can they do? Inclusion and exclusion criteria

Any report which addressed the topic itself was potentially of interest, thus the inclusion criteria were permissive. Article abstracts and summaries were reviewed to identify three main categories of content:

- Recording of patient data
- Computerisation in the hospital setting
- Papers which gave details and examples of CIS capabilities and functions, including opinion, reportage and research

Early on in this process, a possible source of positive, pro computer bias was noted. Preliminary review of the articles identified showed that the majority were positively orientated to the use of computers. Examples include authors such as Millholland (1988) who described problems (but not strengths!) of

using conventional paperwork and Lenz and Metnitz (1995) who described examples of successful CIS, but offered no proof to support this evaluation.

However, this was not an obstacle for the project. Rather, by these authors giving a possibly positively biased description of these systems, this then became the benchmark against which the research findings would be compared. It therefore constitutes a standard, albeit an arbitrary one. In other words, this section represented a review of the claims made for CIS.

Two exclusion criteria only were imposed:

- Reports older than 10 years were not used, because a longer time period would have included systems which would be much less sophisticated than current systems.
- Papers which were outside the acute hospital setting.

This process produced 15 papers which are discussed on pages 16 to 24.

Research findings to explore ways in which CIS can impact upon nurses: inclusion and exclusion criteria

This section was at the heart of the research project and as such a much more stringent set of exclusion conditions was used, because it explored the validity of the research surrounding CIS implementations.

Inclusion criteria

- Any paper which either in the title or abstract identified that research had taken place to explore CIS or similar computerised system

Exclusion

- Papers which did not have sufficient methodological quality to identify bias and to support internal validity (NHS Centre for Reviews and Dissemination 2003). This was interpreted by applying criteria used by Polit et al (2001) for critiquing literature, such that issues of methodology, sample size and interpretation of results were all meaningfully addressed.
- Papers which did not focus upon nurses and nursing practice
- Papers older than 10 years
- Papers which were set outside the hospital environment

Application of these criteria resulted in nine studies being identified. Because

of this small number, the limitation on date was relaxed to 15 years, resulting in a total of 10 studies. Four of these explored the implications of CIS to nursing practices (Bradshaw et al 1989; Hendrickson et al 1990; Lutheran Hospital 1991; Norrie 1997b). The other six were centred around attitudes of nurses to the use of computers (Stronge and Brodt 1985; Brodt and Stronge 1986, Bongartz 1988; Scarpa et al 1992; Large 1994; Lowry 1994). These two issues will therefore be reviewed in separate sections within this chapter, on pages 24-41 and 50-58 respectively.

Because of the modest number of studies found by this strategy, the search was opened to the wider health care setting by using the terms noted in items 10 and 11. By again using the inclusion and exclusion criteria discussed above, with the exception of the stricture upon nursing practice, three further studies were identified (Barley 1986; Kaplan and Duchon 1988; Currie and Brown 1997), which are discussed in a separate section ('the evidence from further afield' pages 60-68). It was decided not to broaden the focus more widely than this, for example to explore application of computers outside of both the hospital setting and indeed health, because of the word limit. It was identified that although more studies might have provided interesting content, this could have been at the expense of thorough critical analysis and could have potentially resulted in a more descriptive review, which would then limit the generation of theory in the concluding sections of the project.

Throughout the life of the project as new material became available, a number of informal literature searches were carried out as new concepts became relevant. For example in Currie and Brown's (1997) study, discussion of the behaviour of oppressed minorities became necessary. These searches were largely limited to the resources of the local university libraries, where sufficient materials were found to explore these new issues.

Lastly, towards the end of the fieldwork, a final phase of literature search was undertaken, where CINAHL and the other strategies identified earlier were again explored to identify work which had been published between the start and finish of the project, as shown in table one.

It is to be noted that in the period which elapsed between the start and finish of the project no new studies were identified which met both the

inclusion and exclusion criteria for the research findings section. However this final stage was very important in identifying literature which was influential in further exploring topics such as resistance to computers within healthcare settings, examples of which include Berg (2001), Timmons and (Tredoux 2002) and gender related issues, examples of which include Trauth (2002) and Wilson (2002). Despite this it is evident that there is a dearth of recent research focussing on CIS within critical care, therefore it is likely that the dissertation will make a useful contribution to this field.

What are CIS and what can they do?

As the therapies available to the critical care area have become more and more complex, the amount of information presented to the nurse at the bedside has become progressively larger. For example, marked haemo-dynamic fluctuations often occur in patients during the immediate phase following major surgery. To detect changes in these variables, various alarm systems are usually activated in the bedside monitors. This technology has been used in critical care units for many years (Stronge and Brodt 1985; Norrie 1999). The list of variables which can be alarm limited is long and covers all of the aspects of invasive and some of the non invasive patient parameters. In a study completed by 23 members of the medical staff involved in cardiothoracic surgery in Finland, the parameters most favoured to provide monitoring of care and to give notice of critical deterioration were found to be heart rate, systemic arterial blood pressures (mean, systolic and diastolic values), pulmonary arterial pressures (mean, systolic and diastolic values) and end tidal concentration of carbon dioxide (Koski et al 1995). This list is far from being exhaustive. In addition, ventilation parameters (minute volume, tidal volume, percentage oxygen, spontaneous respiratory effort, airway pressures, amongst others) will be recorded (Ramayya 1992; Norrie 1999). Powerful vasoactive drugs, analgesia and sedation will be delivered through a number of infusion devices, and vital physiological parameters including urine output, chest drainage, central and peripheral temperatures will be recorded either half hourly, or hourly. Norrie (1999) found that nurses commonly measured at least 26 separate parameters each hour in postoperative cardiac

patients within critical care.

Recording and integrating this mass of data helps the nurse make decisions concerning the administration of drugs and fluids, whether or not the patient will require further medical attention and when the nurse should look towards waking the patient and remove the endotracheal tube used to allow artificial ventilation. Unsurprisingly the conventional paper charts used to keep track of this process are large and time consuming, they also have inherent weaknesses.

Problems with paper charts

The 24 hour observation chart is a feature of most critical care units. It is commonly a single large printed chart with gridlines for recording data in graphical form and spaces for recording clinical events. At present, on units which do not use CIS, the chart is filled in manually by the nursing staff as a continuous record of both the patient's status and the completion of nursing tasks such as eye care, pressure area care and endotracheal suction. In addition, a number of ancillary forms and continuation sheets are employed, to cover care planning, laboratory results, and aspects of assessment involved in admissions and discharges.

The advantage of the graphical nature of the observation charts and the other flow sheets is that they save time over longhand recording and can be used to give quick visual reference of some of the recorded trends (Gordon 1986). In 1988 Millholland identified that the paper chart was the most common repository of clinical information, making it the primary mechanism used in most critical care units for communicating patient information. Now, more than a decade later, this statement still is true. However, problems with the paper medical and nursing records are well known. The charts are frequently physically unavailable due to staff filling them in, information in the chart is available to only one or two people at a time, and they may show poor organisation of the data. Duplication and illegible handwriting adversely affect the retrieval of information. In brief, they result in a cluttered and difficult to read instrument. It is prone to security, confidentiality, and completeness problems (Millholland 1988; Hammond et al 1991; Larrabee et al 2001). Other authors agree. Koska (1989 p37) states that:

'the paper (medical) record is being acknowledged as a woefully inadequate system. Merely managing the medical record is a problem.'

In Dortmund, Koska (1989) described the average medical record as containing 70 pages of information. In addition at least 14 pages a day were needed to keep track of the medical record of a single patient. There is no mention of nursing records, but if they were not already included in the total, they would further compound the problem. There are no figures quoted for the UK, and although the total may be less, due to the majority of patients being treated by the National Health Service (NHS) rather than through private health care insurance (and hence avoiding individual billing), the problem remains.

From a nursing point of view, these reports suggest that the paper chart does not support efficient health care delivery. It also makes timely and careful audits difficult, if not impossible and imposes barriers on nursing research (Millholland 1988). In addition it makes the nurses potentially liable to litigation. The phrase 'if it wasn't charted, it wasn't done' is famous in the lexicon of malpractice lawsuits. Complete information in medical and nursing charts therefore is an important defence against litigation (Tingle and Cribb (2002). Certainly a number of authors including Groom and Harris (1990) and Lenz and Metnitz (1995) identify that CIS can support accurate record keeping and documentation. There is some anecdotal evidence to support this. For example Pryor (1989) found that 75% of physicians working on a unit where a CIS had been introduced felt that patient data was frequently or always more accurately recorded, in comparison to the previous paper chart, but gives no detail to support this claim. Similarly, Kari et al (1988) when reporting on the use of a computerised charting system, found that the reliability of the written record changed inversely with the change in the patient's state. When the patient was stable, the nurse had time enough for numerous manual entries of data. When the patient's condition worsened, the nurse became too busy for manual record keeping. During the period of their study when both electronic and manual charting took place, a patient had an episode of cardiac tamponade and consequent cardiac arrest. There was no documentation of the haemodynamic events during the resuscitation in the manual record. The computerised system however, continued to collect data as before which

could be used as a source in defence of litigation. Similarly, a number of authors such as Burdis (2000) and Pare (2002) identify that electronic record keeping can contribute to improving quality and protecting the confidentiality of patients records, which again is protective against litigation (Tingle and Cribb 2002). More specifically, it has been reported that nearly one third of all errors in critical care involve mistakes in charting or relaying information between shifts (Hammond et al 1991), although this claim is not supported by reference to published research. However, despite the potential benefits claimed for CIS to reduce errors, no research studies have been identified which examine this effect.

The UKCC (1993) also claimed that there was substantial evidence to indicate that inadequate and inappropriate record keeping concerning the care of patients and clients neglected their interests, by impairing the continuity of care, introducing discontinuity of communication between staff, creating the risk of medication or other treatment being duplicated or omitted, failure to focus attention on early signs of deviation from the norm and failure to place on record significant observations and conclusions. This is a serious litany, although again it is not supported by published research.

Current status of CIS

CIS are computerised systems designed to collect, store, organise, retrieve and manipulate the high volume of data related to direct patient care in critical care settings. An extensive database is used to store related patient data (Millholland and Cardona 1983). In a computerised database a collection of interrelated data is stored together electronically to serve multiple applications and multiple users (Saba and McCormick 1986). The attraction of recording all the disparate patient information on a database is the possibility to synthesise a coherent patient record. This is at the heart of what CIS do.

A number of manufacturers of advanced monitoring equipment have taken up the challenge of employing IT to tackle the problem of assimilating and co-ordinating this information. The world wide usage of commercially available CIS as of 2002 is shown in table two. These figures suggest that world-wide there were less than 40 CIS in operation, a minuscule figure in relationship to the world-wide number of critical care units. Clearly, the implementation of

CIS was either in its infancy, or the systems were not attractive to potential customers.

Table two: World-wide implementation of commercially available CIS

Manufacturer	System name	Locations
Clinisoft	Clinisoft Information System	One in Finland One in Sweden
Eclypsis	Sunrise	One in England
Hewlett Packard	Carevue 9000	Three in Great Britain : Royal Brompton, London. Radcliffe NHS Trust, Oxford . Edinburgh University Clinics (sic)
Hospitronics	Atlantis	University of Vienna
Marquette	Clinicomp	One in Belgium 7 installations USA
Siemens	Emtek	Dortmund + more than 20 installations in America

(adapted from Lenz & Metnitz 1995 and Harmsworth and Still 2002)

As of the year 2002, only six applications of CIS had been reported in the literature in the UK. Two of these had been developed 'in house', at Aberdeen Royal Infirmary and at Killingbeck Hospital, Leeds. One commercial system using the Eclypsis sunrise system is in place in Battle, Berkshire. The other three installations all used Hewlett Packard's CareVue, although personal communication with Agilent, the branch of Hewlett Packard which markets this product, suggested that there were in fact eight CareVue systems in use. Because it seems likely that CareVue is the most widely implemented system in Britain, it will be used as an example to show how these systems work in practice.

How CIS are used

CareVue is similar in structure and function to the other commercially available systems (Lenz and Metnitz 1995; Harmsworth and Still 2002). It consists of two file servers which can be housed separately from the critical care unit. Although only one computer is required to operate the system, the second acts as a backup.

Data acquired from the patient are automatically transferred to both computers. Therefore, if one computer fails it is still possible to access the database. A non interruptible power supply ensures that power cuts do not result in the loss of data.

In the critical care unit, typically there is one terminal per bed-space and the number of terminals in use is determined by the number of patients within the unit. There may also be terminals at a central or remote location, in the doctors' office for example, to allow review of the patient's charts away from the bedside. The terminals, which are modified personal computers, are on trolleys, so that they can be moved out of the way if necessary. The system is operated mainly by using a trackball, a hand sized device with a rolling ball and push down validation buttons. Rolling the ball moves an arrow across the screen, while clicking on the buttons produces windows on the screen containing structured text items that the nurse can choose from. Moving the arrow with the ball to the appropriate choice and clicking the button results in the choice being recorded on the display and archive. Duce and Harris (1990) conclude that with comprehensive configuration by the hospital it should rarely be necessary for the nurse to type in freeform text, but whether this is likely in as multidimensional a profession as nursing, is debatable. For example, care of traumatised relatives *is a very individualised process (Brykcynska 1992)* and it is hard to imagine how a pre-composed care plan could cover all eventualities of the nurses' role. Similarly, in 1990 it was stated that *'it will soon be possible for computer systems to acquire data automatically from the infusion pumps and ventilators'*, (Duce and Harris 1990 p41) however this automatic capture of data had only partially been completed at the John Radcliffe NHS Trust, when visited by the author in 2002.

The capabilities of the different systems are summarised in table three overleaf. Two terms are used in the table which require explanation. 'Nurses' work list' is a term used in conjunction with CareVue and is a feature which pulls in information from the care plan, drug chart and doctors' notes to produce an hour by hour timetable of what needs to be done for the patient during the shift (Duce and Harris 1990). Secondly most hospitals in Britain use a HIS. This is an example of a Local Area Network (LAN), a method of connecting computers together so that they can share facilities, such as hard

discs, data and printers (Benson and Neame 1994). The LAN may include biochemistry, microbiology, radiology, admission and discharge information (Pluyter-Wenting 1992). Ability to acquire this information and include it within CIS is of benefit as it can eliminate repetitive entries and increases speed of access to this information. All four systems guarantee confidentiality by the use of passwords.

Table three: Comparison of the capabilities of CIS

	System			
Facilities	**ABICUS**	**CareVue 9000**	**Eclipsys sunrise**	**Killingbeck**
Admission details*	yes	not stated	yes	no
Access to HIS	not stated	yes	yes	no
Drug charts	yes	yes	yes	yes
Drug dose calculation	yes	yes	yes	yes
Nursing care plans	yes	yes	yes	yes
Nurses' work lists	not stated	yes	yes	not stated
Medical notes	yes	yes	yes	not stated
Automated access:				
Fluids	no	yes	yes	no
Ventilator parameters	no	yes	yes	no

Adapted from Crewe et al (1987), Gilhooly et al 1991, Duce and Harris (1990); deKeizer et al (1998) and Harmsworth and Still (2002)

From the published information concerning these installations, the picture emerges of the way in which CIS are used. Physiological data from the monitoring systems such as blood pressure, heart rate and temperature are acquired either automatically, or entered directly from the monitor display by the nurse, into the database. This may include ventilator observations. Most other parameters such as fluid administration and urine output are manually entered using a trackball, mouse or keyboard. The CIS uses these data to automatically calculate fluid balances and trends. In addition, clerical nursing duties are expedited by the CIS, using pre-formatted text, which may or may not require supplementing. Drug prescription, dosages, calculations and laboratory results are also recorded on the database and are readily available to the bedside nurse and physicians.

Can CIS support the nurses in critical care?

A striking finding from a review of the literature is the absence of qualitative work which can explore the ways in which CIS can enhance the primary

caring role of the nurse. This may be largely due to the fact that medical research has led in the development of the systems and therefore possible benefits have largely been discussed in medical terms. However there are many nursing issues to be explored. For example, currently there is a paradox in the amount of care versus documentation that nurses can devote to their critically ill patients.

As the patient becomes progressively more unwell, the time the nurse needs to spend on clerical tasks, such as copying information from the monitors and ventilators, recording and calculating fluid balance and updating care plans increases, compromising the amount of time spent on delivering possibly life saving nursing interventions (Duce and Harris 1990). In addition to the recording of patient observations, nurses have a duty to maintain accurate and up to date care planning. Indeed the UKCC (1993) identified that making and keeping records was an essential and integral part of care. Conventional care planning has been seen by some as a time consuming paper exercise (Newton 1995a) and therefore there is an added impetus for efficient computerised care planning to be used by nurses. However, when implementing a computerised system for care planning, Newton (1995b), found that nurses were anxious about the effects on patient care and believed that all the unsatisfactory aspects of manual care planning would apply to the new ones, which would still not be used effectively. A number of manufacturers offer a care planning facility as part of their CIS, and claims have been made such as enhanced efficiency and structure (Vedovelli 1995). Pryor (1989) reviewed the use of computerised care plans and suggested that quality of documentation may indeed be improved, but found that the process was time consuming and might result in less time being available for patient care.

Training

Training of staff in using CIS is a major component and cost of any implementation (Plummer and Warnock-Matheron 1983; Russell and Alpay 2002). When Norrie and Blackwell (2000) put forward a financial case for the implementation of a CIS it was suggested that the salary for a senior nurse working on a full time basis would be an integral part of the cost of the system. In support of this, at the John Radcliffe NHS Trust where CareVue is installed,

there is a full time systems administrator, a senior nurse, employed to train and update the nursing and medical staff. Green et al (1991), looking at ABICUS found this to be an important role and concluded that the presence of a well qualified nurse clinician was a strong motivator for the use of the system, because this person educated the staff in the use of the system and remained with the staff to trouble shoot. This experience was supported by the workers at Killingbeck where problems of intermittent technical backup and unstructured teaching opportunities were reported (Stoodley et al 1992).

Extensive staff turnover in the order of 33% *per annum* (Pryor 1989) makes ongoing training a necessity (Phillips et al 1982) and has been shown to be costly (Paganelli 1989). Although more recent systems may be more user friendly, the implementation of CIS undoubtedly still requires a considerable investment in time and effort to be put into training employees to use it optimally (Alberdi et al 2000). Such computer systems may be the employees' first introduction to the use of the computer in the workplace. If this introduction is perceived as a positive experience by the employee it may set the stage for a smooth and less troublesome implementation (Kjerulf et al 1984; Avila and Shabot 1988).

Clearly there are a number of issues to be considered when making a case for the implementation of CIS. Much has been claimed but little has been proven. The next section will explore the research which examines ways in which CIS affect nurses in acute and critical care.

Nurses and computers

Within the literature concerning nurses and CIS, there is a dominance of quantitative studies with only one qualitative study reported. Unfortunately, even this contribution had to be discounted because of insurmountable problems with methodology. Pare (2002) examined three case studies within a hospital and used semi structured interviews to explore aspects of the relationship between workers and success of CIS. However of these cases, only one explicitly dealt with nurses and no sampling strategy or size for this group was given. Neither were details of data collection included. In addition, no linkage was shown between interview materials and the highly descriptive results sections given, nor was linkage shown between the results and the generation of theory. Lastly, it was impossible to link the theory components

with particular groups of respondents, thus it was impossible to determine whether the theory was grounded in nursing, medical, managerial or other perspectives.

This preponderance of quantitative investigation may be because the work was largely undertaken by medical staff, who are likely to have been schooled in scientific methodology. The majority of these reports have been published in the early to mid 1990s. It is therefore paradoxical that as these systems have become more widespread there has been less specific literature dedicated to them. It could be hypothesised that this may be because in North America during this period there was an acute shortage of nurses which highlighted the need for methods to make their work more efficient (Hendrickson 1990). It is also possible that the CIS are no longer seen as being novel and that their use has become more accepted. Despite these possible perspectives, the ways in which nurses use these systems remains a legitimate subject for research, because as will be demonstrated, the case for CIS within critical care has not as yet been made with rigour. This section will review four studies which explore the ways in which acute nurses work and the possible impact of computers upon them.

Hendrickson et al (1990) were nursing administrators who looked at the way nurses spent their working time within the context of severe nursing shortages in Northern America, a situation which perhaps has resonance with the current National Health Service (NHS). This study will be examined first because it is more generalised in content than the others, looking at the potential impact of computers upon different groups of nurses, rather than the impact of CIS within critical care.

It examined a number of specialist units, these being orthopaedic, medical, surgical, neurological, obstetric and gynaecological and paediatric. The study took place within a non specified large metropolitan hospital in the USA. In order to quantify the ways in which the nurses worked Hendrickson et al (1990) developed their own taxonomy of nursing activities (table four). This was based upon descriptions of a *'typical days work flow'* (p33) as described in an unspecified number of interviews with nurse managers and staff nurses. A work sampling technique was used. Observations were taken every 15 minutes during an eight hour shift by a team of six trained observers who

covered two shifts per day over a seven day period. This can be calculated to give a total of approximately 2,600 observations per specialist unit. The observers were composed of graduate or senior undergraduate nursing students, who may reasonably have some insight into the work which was being observed.

Table four: Definitions of activity categories used by Hendrickson et al (1990)

Category	Components of category
With patient	All nurse/patient time, either in the patients room or in hallway
Patient chart	Any work with the chart.
Preparation of therapies	Time spent in preparing intravenous therapies, medications etc.
Shift change activities	Report, counting narcotics, getting assignments, making patient rounds, either during report or afterwards
Professional interaction	All face to face communications, except communications with patient: will include communications with visitors, doctors, social workers, other nurses etc.
Miscellaneous, clinical	Any clinical activity not listed above
Checking physicians orders	Checking physicians orders for tests, medications etc., including cross checking medication order against the medication book.
Unit orientated in service	Time spent on in service education, including policies, procedures or case conferences
Paperwork	Filling out forms, incident reports, requisitions or any work with paper other than physician orders or charting.
Phone communications	Any use of the telephone
Supplies	Any time spent outside of the patient room obtaining supplies
Miscellaneous, non clinical	Any non clinical activity not listed above. Meals and breaks are listed in this category.
Don't know	

Inter-rater reliability was addressed and was assessed by some duplication of study. Agreement between observers was found to be greater than 91%.

For the purpose of brevity, the average results from all six clinical venues will be used. The study found that the nurses spent 31% of their time with their patients. On average, a larger amount, (45%) was spent in indirect patient

care of a clinical nature, which comprised a broad range of activities, the majority of which can be seen as being necessary to support the delivery of direct patient care (see table five).

Table five: Taxonomy of activities used by Hendrickson et al (1990)

Activity	Constituents	Time spent per activity (%)
With patient	With patient only	31
Indirect-clinical	Patient chart Preparation of therapies Shift change activities Professional interaction Miscellaneous clinical Check physician orders Unit orientated in service	45
Indirect-non clinical	Paperwork Phone communications Supplies	10
Miscellaneous non clinical	Miscellaneous non clinical	13
Don't know	Don't know	1

'Indirect clinical' activities accounted for 10% of the shift, and 'miscellaneous non clinical' accounted for 13%. Hendrickson et al (1990) noted that percentages of time spent in specific activities were fairly consistent across the seven days of the week, and in terms of the amount of time spent with patients, across the different clinical areas.

From these results, Hendrickson et al (1990) drew a number of conclusions. Firstly, a significant proportion of the nurses' time was spent on non clinical activities. This was felt to be wasteful, at least some of this could have been undertaken by suitably trained support personnel. In particular, it was identified that if support staff were assigned transport and messenger duties, nurses could potentially have 10% more time for essential nursing tasks (Hendrickson and Doddato 1989). Secondly, the nurses spent 10% of their day in direct preparation of therapies, including intravenous therapy solutions. The authors therefore suggested that with increased support from pharmacy, it may be possible to save this time and devote it to patient contact, by decentralising pharmacy services and using satellite or mobile pharmacy systems. However hospitals also experience difficulties in recruiting and retraining pharmacists (Manasse 1988), and so this approach may contribute

towards a flexible approach, but is unlikely to solve the problem. This study does therefore suggest that there might be other ways than computerisation to support the work nurses undertaken within the acute setting. By implication it suggests also that computerisation is not a panacea, and that it would be wise to optimise working practices within a clinical area before implementation of a CIS.

There are further issues. It was assumed that by using different professional groups to undertake these tasks which do not fall directly within the remit of the nursing staff, that time could be saved. This time would then be used to deliver better quality patient care. However, the authors cite no evidence to support this. In the absence of this evidence, it is impossible to ascertain whether the use of other professionals would result in the desired effect, and as will be explored later, this is a common naive assumption used by authors when discussing changes of work practice within complex systems.

Finally, Hendrickson et al (1990) identified a number of activities which they suggest could meaningfully be enhanced or expedited by the use of computerised systems. They reported that 38% of the nurses' day was spent in activities that involved communicating information. These included charting, receiving shift report, professional interactions, checking physicians orders, paperwork and those phone calls that were requests for routine information. It was reported that computerised systems could impact on this although no proof was given to support this. Secondly there was no evidence given that *if* time was saved this would then be used to support nursing care.

Therefore although of interest, there are too many assumptions made in this work for it to be influential. In addition, the sole use of quantitative methods to explore the nature of the nurses' working experience can be questioned. For example just because a computerised system might result in the nurses spending more time *'with patients'* does not necessarily mean that a more meaningful or therapeutic encounter with the patient resulted. For reasons such as this, a number of nursing researchers have moved to the use of qualitative research (Yin 1994; Baillie 1995). As an opening position in developing a more suitable methodology, a fairly straightforward case could

be made for the addition of a set of interviews in such studies to assess the quality of the nurses' experiences.

Bradshaw et al (1989) used a work sampling methodology to measure the time spent by intensive care nurses in all activities related to patient care, before and after implementation of a computer based charting system in a thoracic unit in the Latter Day Saints Hospital in Utah. The research team was multidisciplinary and included the acting director of intensive care nursing. From this work, the precise nature and capabilities of the CIS used are unclear. Bedside terminals were installed and nursing care plans and charting were included within the system, as was patient information, but whether the system interfaced with machinery such as ventilators and syringe drivers was not stated. Given the early year of the implementation (1988) this seems unlikely.

The unit was reported as having been already partially computerised, for example data on blood pressure, heart rate and temperature were already automatically acquired. This information was entered by computer technicians. The study was performed in two phases, one before and one after installation of the CIS. The post implementation phase took place approximately six months after the computerised system was up and running. This is an important issue, in that there is little evidence published concerning the amount of time that nurses need to use, become familiar with and hence optimise the CIS (Pryor 1989; Ambroso et al 1992). Indeed it has been suggested (Norrie 2000) that it might take up to a year for benefits (if such there be) to become evident following implementation of CIS.

The work sampling technique was designed to speed up and simplify traditional time study analyses, by using randomised sampling of numerous workers. It was claimed that this could yield accurate results because the workers were not aware of when they were being observed and the large numbers of workers observed tended to cancel out differences. A pilot study was carried out, using a traditional 'time study' technique (which appears to refer to continuous rather than random series of brief observations). In the pilot a nurse with a stopwatch recorded the time spent by a nurse while caring for a patient, based upon ten categories of nursing activity derived from the job description of the nurses (table six).

Whilst the use of a pilot study is valuable in that this can improve the project and assess its feasibility (Polit et al 2001), the scheme of categorisation is a weakness. The use of a job description for this purpose can be seen as being problematic, in that this may represent a viewpoint of management, rather than an accurate reflection of work undertaken by bedside nurses.

Table six: 10 categories of nursing activity (abridged) taken from Bradshaw et al (1989)

1	Patient care
2	Charting
3	Oral communication
4	Obtaining supplies
5	Planning nursing care
6	Reporting
7	Transferring patients
8	Data review
9	Checking medication schedules
10	Non nursing activities

The two periods of work sampling took place in 1988. Observations at random were taken every 15 minutes, 24 hours a day for a seven day period. Observers were drawn from among ward clerks and computer technicians employed within the thoracic unit. This is a serious weakness, in that non nurses were used to analyse the work of nurses and it is questionable as to their suitability to undertake this: for example it is hard to imagine a research project where nurses would be expected to analyse the work undertaken by computer technicians. This imposition of values must put a limitation on the validity of this research (Ellis 1994; Sandelowski 1999). Secondly, the group of computer technicians might have been subject to bias in their recording. It has already been noted that prior to implementation these technicians entered patient data, but after implementation, this work was carried out by nurses. This clearly would have implications on the work practices of this group, which could have been positive (i.e. technicians relieved of a burdensome duty) or negative (the change in practice possibly resulting in redundancies).

A total of 7775 observations were made in phase one (prior to implementation of the CIS) and 8050 made in phase two (post implementation of the CIS). A summary of the findings is given in table seven.

Statistical comparison between the two sets of findings was carried out using Student's *t*- test. There was a 5.9% decrease reported in the time spent in patient care ($p< 0.001$) and a 6% increase in the time spent in charting ($p< 0.001$) and this was constant over both day and night shifts, following implementation. These are interesting and indeed surprising results, given that these are entirely contrary to the claims made by the manufacturers and proponents of CIS systems (for examples see Hewlett Packard 1989; Duce and Harris 1990; Lenz and Metnitz 1995). How can these findings be explained?

Table seven: Summary of findings from Bradshaw et al 1989, percentages of nursing time spent at various activities

Activity	Pre implementation	Post implementation
Patient care	49	43
Charting	18	24
Non nursing	9	9
Oral communication	8	9
Obtaining supplies	8	8
Reporting	3	3
Other		
Data review	1	1
Drug scheduling	1	1
Nursing care plan	1	1
Transfer	1	1
Total for other:	4	4

Bradshaw et al (1989) observed that patient acuity (the amount of illness as determined by an unspecified scoring system) was lower in the second sample. Their conclusion was that the amount of time nurses spent in patient care was determined by the patients' needs and was not influenced by the nature of the charting system used. In other words an uncontrolled variable had been introduced and this had resulted in these unexpected findings. They noted that a computerised system by its nature *should* facilitate the acquisition of data and (amongst other things) help communication and decision making. However this finding is not substantiated by evidence. It seems extraordinary to have devised and undertaken a research project and then discount its findings because they did not correspond to your expectations. As will be seen later, this is not the only instance where the findings of a research

project investigating CIS implementation have been subject to dubious retrospective interpretation. The results suggested that less time was spent in delivering patient care after the CIS was implemented. In the absence of convincing evidence to the contrary, this should be allowed to stand.

Bradshaw et al (1989) postulated four further limitations to efficient usage of a CIS. These were: (1) the computer based charting system was not comprehensive and still involved paper documentation (2) nurses did not always make full use of the capabilities of the computer based charting system (3) differences in time required to chart by computer may have been too small to record and (4) any savings of time may have been spent in other activities rather than delivering patient care. Although this is an interesting list of suggestions, it should be noted that none of these actually derive from the research undertaken and so are of limited value. One obvious criticism which can be made are the restrictive methods employed. Again the study relied purely on quantitative methods. As has already been discussed, nursing is multifaceted and difficult to define. As with Hendrickson's (1990) study, a case can be made for the inclusion of qualitative research to explore the nurses' experience of using CIS.

In 1991, the Lutheran Hospital of La Crosse in Wisconsin, conducted what they described as the first work sampling study on the impact of CIS in an intensive care unit (although Bradshaw et al (1989), perhaps more legitimately can lay claim to this). In October 1989 an activity study was conducted for five days, prior to the implementation of CareVue. The study consisted of trained observers making observations of nurses every 15 minutes for each of the five day study periods. An activity list was compiled into nine major sections (see table eight).

Table eight: Activity classification taken from Lutheran Hospital (1991)

	Activity
1	Assessment
2	Activities of daily living
3	Discharge/Transfer
4	Medications
5	Procedures
6	Communication
7	Indirect care
8	Miscellaneous
9	Other procedures.

The origin of the categories used was not clearly explained. It was stated that it included *'established internal and external patient classification data as well as normative data on patient classification from other institutions'* (p2), but this is not a clear statement. Observations were recorded in four hour shifts throughout 24 hours each day for the five days of each study period. Observations were taken every 15 minutes, therefore observation of a nurse working a 12 hour shift would result in 48 activity recordings. The exact sample size chosen was not stated in the article, nor were the number of observations made. Inter-rater reliability was not addressed. The only checks discussed were carried out during the inputting of data, although the nature of these are not stated. The study was carried out prior to implementation of the CIS and then one year after the implementation of the system. A comparison of the activities prior to and post implementation is given in table nine.

Table nine: Comparison of pre implementation of CIS and Post implementation on total activities at the Lutheran Hospital (1991)

Activity	Pre implementation % total activity *	Post implementation % total activity *
Assessment	11	10
Activities of daily living	7	14
Discharge/Transfer	1	2
Medications	9	10
Procedures	7	7
Communication	3	3
Indirect care	47	39
Miscellaneous	14	13
Other procedures	2	1

*All figures to the nearest percent

The Lutheran Hospital study is an interesting piece of work, but it is flawed. Firstly the categorisation of nursing activities is not justified. It contains a number of elements which appear to have been arbitrarily included in disparate categories. For example, it seems likely that the category of 'activities of daily living' was compiled to represent the situations in which a nurse or support worker would supplement the patients' own needs for basic hygiene, washing and dressing, eating and drinking and elimination (Hinchliff

1996). However, the list includes rogue elements. For example, 'adaptive equipment application' is included and it is open to conjecture what this refers to. Indirect care is a rather mysterious category, which appears to include a number of housekeeping and administrative elements ('errands', 'linen hampers'), necessary for the unit to run smoothly. This problem with categorisation has been highlighted in the previous studies to a greater or lesser extent. It appears to be caused by lack of a systematic understanding or definition of what nursing is, and the apparent belief that nursing is susceptible to a simple reductionist analysis, however no evidence is included to support this.

Secondly, the research was undertaken by an in-house team, which raises questions surrounding bias. The system employed was expensive (approximately £38,000 per bed at 1997 costing quoted in Norrie 2000a). With such a significant cost it might have been less than wise to have reported that the system did not achieve the goals it set out to! These intentions were outlined in the introduction and included the desire to spend less time on charting, a decrease in indirect care activities and an increase in hands on nursing duties (Lutheran Hospital 1991). Indeed, there is evidence that in the conclusions, significant lengths were gone to present the study in as favourable a light as possible. For example in the introduction to the report, it was stated that that there was a decrease in time spent in charting of 22%, a decrease in indirect care activities of 16% and an increase in hands on nursing of more than 100%. Whilst this may be strictly true (although an increase from 7% to 14% for time spent in the activities of daily living i.e. an extra 7% of total time is rather less exciting than the headline figure), it is reported that a *t*-test from the totals of all nine activity categories revealed that there were no significant differences between the means at a 95% confidence level. Therefore it is debatable whether any of the spectacular claims for the computerised system can be justified. In fact, it would have been more accurate for the authors to claim that despite the computerised system being implemented, *no* significant changes in the way that the nurses worked was found.

Again, a case can be made for including a qualitative investigation within the research project. Despite the inability of the quantitative methods to

identify statistically significant results, it is likely that CIS changed the ways in which the nurses worked. This might have been identified through using appropriate research methods, such as interviews, which could have explored the nurses' subjective views. This might have been valuable in exploring issues such as whether the nurses accepted the system and used it to its optimum ability.

One final study will be considered within this section. Norrie, then working as a charge nurse in cardiothoracic intensive care in the East Midlands of England, developed an original research tool to explore the possible impact of a CIS. This used a diary style quantitative questionnaire composed of tick boxes (Norrie 1997b). Nursing activities for the duration of a 12 hour day shift were split into five categories (table ten). They were: Direct Nursing Care (DNC), Clerical Nurse Duties (CND), Patient Assessment (PA), Non Nursing Duties (NND) and Time Out (TO).

It has been claimed that CIS would increase the amount of time that nurses have available for delivering direct patient care (Shabot 1989; Imhoff 1992 and Lenz and Metnitz 1995). This was investigated by the category of DNC. Secondly, a number of authors stress the ability of CIS to increase accuracy of recording and decrease time spent in the acquisition of patient data (Draper 1989; Clemmer and Gardner 1992). This would be reflected in CND. The third category of PA was intended to identify the ability of CIS to support assessment of physiological parameters obtained from monitoring equipment and to assist communication between health care workers (Abenstein et al 1992; Stoodley et al 1992; Lenz and Metnitz 1995).

With a sample size of 36 respondents, representing 432 hours of nursing time, Norrie (1997b) found that the nurses spent approximately 41% of their time in DNC, 19% in CND, 22% in PA , 7% in NND and 11% in TO.

This work has some strengths. Firstly the research tool was constructed by a practitioner working within the field. Secondly, it was piloted within the research setting and amended accordingly. Thirdly, the categorisation of nursing activities had clearly focussed aims and was applicable to a clearly set research question. However, again the study also had significant limitations.

Table ten: Activity classification taken from Norrie (1997)

Categories of nursing activity	Description
Direct nursing care	All activities in which the nurse is directly attending to the patient, for example communicating with patients and relatives, administration of drugs, wound dressings, washing patients, helping other nurses who are involved in patient care, performing endotracheal suctioning, turning patients, performing pressure area care and helping medical staff in their investigations.
Clerical nurse duties	All activities associated with documentation and recording, for example, recording observations, blood results, fluid balances and ventilator parameters and planning and the evaluation of care planning.
Patient assessment	Activities associated with observation of the patient. It would include assessing physiological and/or psychological state, observing parameters derived from monitoring equipment, providing information for other health care professionals and nursing hand over.
Non nursing duties	Work that did not require the skills of a trained nurse to be completed, for example cleaning and preparing bed spaces, ordering stores, sundry clerical duties and answering telephones.
Time out	Time that was physically spent outside the unit, whether on break, at meetings or being involved in teaching.

Firstly, weaknesses can be identified within the categorisation. For example, answering the telephone may indeed be a non nursing duty, but it could also be part of patient assessment (getting results) or DNC (discussion with relatives). In addition, the work study questionnaires were completed by the bedside nurses, which is a possible source of bias. On the one hand, this could remove the interpretative error of assessors who may not have sufficient knowledge or insight to analyse the activities they observe. Conversely, it could be argued that this form of investigation, where the subject is also (in effect) the observer, could be more liable to bias. In addition, there was no account of inter-rater reliability.

However, in addition to the global statistics, Norrie (1997b) generated descriptive statistics which charted the activities of the nurses throughout the

working day and found that observable features such as nursing hand-over, hourly recording of observations and breaks were faithfully recorded, suggesting that this supported the validity of the research.

The findings were used to propose a financial case for purchasing a CIS (Norrie and Blackwell 2000). This suggested that a CIS would pay for itself within five years of implementation based upon the amount of nursing time that could be saved in two main categories, CND and PA . However, as noted when examining the claims of Bradshaw (1989) and Lutheran Hospital (1991), the basis for making such a claim is so flimsy as to be negligible. This was later discussed by Norrie (2000), wherein the financial case was essentially refuted, and must remain so, unless sound evidence is presented that CIS can actually save nursing time.

Did this study have any value? On a prosaic level, Norrie's (1997b) research tool had two main benefits: the categorisation used was the simplest amongst all the quantitative studies and it actually used the interpretative skills of the nursing staff to explore the ways in which they worked.

Four reductionist studies have been analysed. The question is therefore raised, can the studies be compared, in order to gain insight into the ways in which nurses work within critical care and whether CIS can support them?

The five-fold classification

Bradshaw et al (1989) Hendrickson et al (1990) and Lutheran Hospital (1991) all used different schemes of categories to investigate essentially the same phenomenon: how the observed nurses spent their time. The choice and delineation of category in all three studies to some extent lack both a theoretical model and rigour. Hendrickson and Kovner (1990) agree that comparability of studies is a problem. They suggest that systematic investigations across institutions with different computer systems are needed to form firm conclusions about the effects of computers on nurses' time. However this itself can produce problems. It may be argued that the accuracy of a study will increase as the categories become more precisely defined, but as the numbers of categories increase this will make the study unwieldy and more complex to analyse. More pragmatically it will make the study harder to carry out. As the list of variables increases, the training needed for observers

will also increase, as will the complexity of filling in the research tool in the clinical area.

Norrie's (1997b) study similarly lacks an adequate theoretical underpinning for its variables. It does however have advantages over the others, in that it is simple to use and it was developed within the same group of nurses who used it. In addition, because it used five broad categories, for the first time it is possible to compare the results with the other three studies. This is because most, if not all of the variables identified in the preceding studies can be allocated a place within these broader categories. The pre-implementation figures in Bradshaw et al (1989) and Lutheran Hospital (1991) will be used. For example, 'Oral communication' (from Bradshaw et al 1989) is a component of the category PA used in Norrie (1997b). Similarly, 'checking physicians orders' (from Hendrickson et al 1990) fits within the category of DNC and lastly, communication/psychological/social (Lutheran Hospital 1991) would again fit within DNC. A full demonstration of the ways in which the other three studies fit within Norrie's (1997b) categories is shown in tables 11, 12 and 13.

Table 11: Comparison of categories between Bradshaw et al (1989) and Norrie's five-fold classification

Categories used by Bradshaw et al (1989)	Five-fold Categorisation	% nursing time in original study
Patient Care	Direct Nursing Care	49.1
Charting	Clerical Nurse Duties	18.2
Oral communication	Patient Assessment	8.1
Obtaining supplies	Non nursing Duties	8.0
Planning nursing care	Clerical Nurse Duties	0.6
Reporting	Patient Assessment	3.1
Transferring Patients	Direct Nursing Care	0.6
Data Review	Patient Assessment	1.6
Checking Medication	Direct Nursing Care	1.4
Non nursing activities.	Non nursing Duties	9.3

Table 12: Comparison of categories between Hendrickson et al (1990) and Norrie's five-fold classification

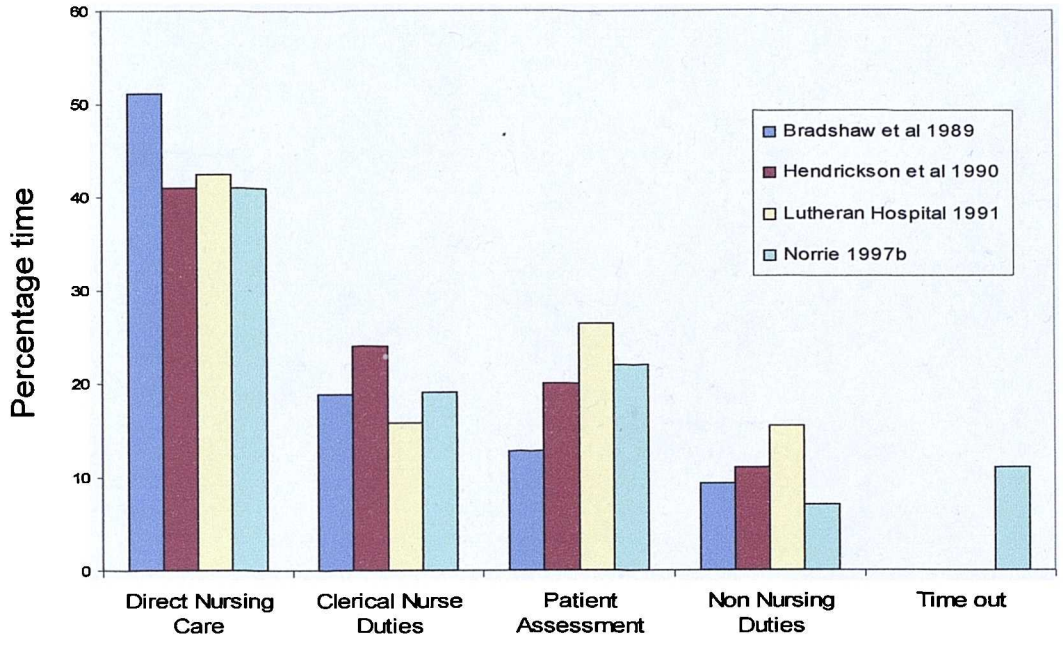
Categories used by Hendrickson et al (1990)	Five-fold Categorisation	% nursing time in original study
With patient	Direct Nursing Care	31
Patient Chart	Clerical Nurse Duties	11
Preparation of therapies	Direct Nursing Care	10
Shift change activities	Patient Assessment	9
Professional interaction	Patient Assessment	8
Miscellaneous, clinical	Non nursing Duties	4
Checking physicians orders	Patient Assessment	3
Unit orientated in service paperwork	Clerical Nurse Duties	0
Phone communications	Non nursing Duties	3
Supplies	Non nursing Duties	3
Miscellaneous non clinical	Clerical Nurse Duties	13
Don't know	Non nursing Duties	1

Table 13: Comparison of categories between Lutheran Hospital (1991) and Norrie's five-fold classification

Categories used by Lutheran Hospital (1991)	Five-fold Categorisation	% nursing time in original study
Assessment	Patient Assessment	10.7
Activities of daily living	Direct Nursing Care	7.0
Discharge/ Transfer	Direct Nursing Care	0.5
Medications	Direct Nursing Care	8.8
Procedures	Direct Nursing Care	7.1
Communication/Psycho-logical/Social	Direct Nursing Care	3.4
Indirect care	33% DNC	15.7
	33% Assessment	15.7
	33% Clerical	15.7
Miscellaneous	Non nursing Duties	13.9
Other procedures	Non nursing Duties	1.5

Using this ability, comparison between the four studies becomes possible. Upon inspection, the results from all four studies can be seen to have marked similarities, as shown in graph one. Unsurprisingly however, some anomalies are also found which may represent incompatible aspects of the methods used. Firstly, only Norrie (1997b) gave values for TO because the observers in the other studies only reported upon activities which physically took place within the clinical area, whereas in Norrie (1997b), the investigative tool was completed by the nurses themselves, and covered their entire shift between commencement and completion. Fortunately, within all the studies, this was

Graph 1 Comparison of the four studies of nursing activities using the five-fold categorisation of Norrie (1997b)



by far the smallest item and so its omission or inclusion does not represent a major obstacle in an attempt to produce a meaningful comparison. Secondly, one aspect of the Lutheran Hospital Study (1991) was resistant to re-categorisation. This was because it used a category entitled 'indirect care' which was not explained, therefore the time spent in this category needs to be distributed elsewhere. PA and CND can reasonably described as 'indirect' aspects of care, but paradoxically it can be deduced that some of the Lutheran Hospital 'indirect' activities can be fitted within Norrie's (1997b) category of DNC, because of the broad permissive nature of the five-fold categorisation. Inspection of the other categories used in the Lutheran Hospital study reveals that items such as communication with patients and relatives which were included in DNC, were not included elsewhere in the Lutheran Hospital categorisation at all. These are however important aspects of care. This suggests that the Lutheran Hospital used a very limited definition of care and 'indirect' may refer to activities which supported patients, but did not involve physical interventions, although these were included in DNC. Therefore, this category will be split equally between DNC, PA and CND. It should however be noted, that this constitutes a limitation in the re-categorisation. However *despite these points and given the disparate and* independently derived methods employed, it is remarkable that these were the only examples of a poor fit between the individual studies and the five-fold categorisation.

Table 14 gives a comparison of the percentages of nursing time derived from all four published studies expressed within the five-fold categorisation.

Table 14: Comparison of percentages of nursing time derived from three published studies in comparison with Norrie's five-fold classification

Five-fold categorisation	Hendrickson et al 1990	Bradshaw et al 1989	Lutheran Hospital 1991	Norrie 1997b
Direct Nursing Care	41	51	42	41
Clerical Nurse Duties	24	19	16	19
Patient Assessment	20	13	26	22
Non Nursing Duties	11	9	15	7
Time out	not included	not included	not included	11

(all figures rounded to the nearest percentage)

This will briefly be discussed. The amount of time spent on DNC varies between 41% (Norrie 1997b) and 51% (Bradshaw et al 1989). These results seem remarkably consistent, as does comparison of the values of the time spent in undertaking CND, ranging from 16% (Lutheran Hospital 1991) to 24% (Hendrickson et al 1990).

The comparison is less precise in the categories of PA and NND, although again there are areas of close correlation. Lastly, in all four studies, with one exception (Bradshaw et al 1989 PA) the amount of time spent on NND was the smallest (7-15%). It can be concluded therefore, that this process of comparison between the five studies may have some value. How can this line of reasoning contribute to this research project?

The studies that have been reviewed have significant weaknesses, some of which have already been discussed. In addition cultural differences may be relevant. Firstly, because three of the studies originated within the USA and secondly, because over the last five years the work within critical care units has changed markedly, as discussed in the first chapter (Pilcher et a 2001; DOH 2000). Perhaps the feature which affords the most criticism is that of trying to place nursing within a reductionist and purely quantitative framework. This suggests that the five-fold categorisation can only be regarded as a provisional scheme, which may have use in analysing the ways in which critical care nurses work. It may therefore be a tool that can be used in later stages of the project to un-pick the ways in which CIS can help nurses, or it may be inapplicable. If the former is the case, then the five-fold categorisation may be a useful addition to the armoury of the researcher who wishes to explore the ways in which critical care nurses work. If the latter is the case, then the argument can safely move on, consigning these reductionist studies to the margins of legitimate study, in itself a useful contribution.

Moving away from quantitative methods

Within this chapter thus far, there has been a general shift in credence away from the idea of solely using a quantitative approach to investigate the application of CIS within critical care. It is certainly within the context of the project to point out that the discussions generated thus far do point consistently towards identifying complex relationships which are difficult to observe, understand and hence define. To support this argument, Myers

(1994) agrees that with information system management *'positivist assumptions are invalid when they are applied uncritically to social reality'* (p54). Myers instead suggests that a qualitative framework for this field of research is desirable, because it can allow the integration of multiple perspectives. This view is given further support by Markus (1993) who suggests that successful use of information systems is multi-factorial, and can be due to cognitive style, personality traits, and the engineering of interfaces. Markus (1993) defines these as 'sociotechnical' variables (p443) and taken together with Myers (1994) stance, supports the call for a more subjective understanding of the factors which influence the ways in which workers utilise these systems. For example it can be suggested that if a system is optimised for a particular group of workers that this may result in it being used optimally (Timmons and Miller 2002). However in order to do this, the values and requirements of the workers must first be ascertained and qualitative research would be the most appropriate tool to explore these processes (May 1997).

However having made this judgement, it then becomes incumbent to identify suitable frameworks for further research. Logically, this discussion will be explored in detail within the methodology section. At this stage it is probably adequate to identify that suitable candidates do indeed exist, a discussion which can inform the rest of the literature review. To find these candidates it is necessary to look within the social sciences, because this is where the workings of human society and its interactions are systematically studied (May 1997), a position which is emblematic of the ways in which nurses work. Indeed within this discipline, there are many options available for the researcher to choose from. Examples include grounded theory, phenomenology, the use of case studies and ethnography, to name but a few. What these frameworks hold in common is a move away from the viewpoint that there is an objective reality which can be explored using empirical research tools, towards a viewpoint that it is more valid to explore the way that people function within their social situations (Silverman 1993; May 1997; Bowling 1997). Therefore, they are all explicitly tied in with the context in which people live and work. This attitude can be described as the antithesis of positivist research, where variables are controlled in order to remove or minimise this context. For example, grounded theory bases its legitimacy in

the generation of theory which is 'grounded' or based within the research environment (Glaser and Strauss 1967), phenomenology explores the lived experiences of its subjects (Crotty 1996) and case studies, as the name suggests, explore one instance of a phenomenon and do not intend to produce immediately generalisable data (Denscombe 1998).

It was noted earlier that many benefits have been claimed for the uses of CIS in critical care, but little sound evidence has been given. This statement has been given support in this review. Neither Bradshaw et al (1989) nor the Lutheran Hospital's (1991) report were able to show a saving of nurse time nor improvements in nursing practice. Therefore the research agenda remains wide open and it will indeed be an original contribution to knowledge if valid research can explore these issues.

Finally, it may be timely to state a perspective which has not been addressed by the researchers thus far. If nurses are to be the main users of CIS, as a first step it would seem logical to firstly identify their requirements, before trying to measure whether the systems meet them or not.

Nurses' attitudes to computers

Again, the literature is dominated by quantitative studies, to the extent that no qualitative studies were identified during the literature search. A recurrent theme thus far has been the limited input of nurses into the utilisation and evaluation of CIS through research. In particular, there have been few attempts to examine the everyday experiences of the nurses who use such systems within their practice (Derbyshire 2000). These experiences are likely to be influential when formulating the nurses' attitudes, which will either promote acceptance of, or offer resistance to the CIS within the clinical setting (Avila and Shabot 1988; Gilhooly et al 1991).

A universally accepted definition of attitude probably does not exist. Professional use and definitions of the term attitude appear to vary between conceptual and theoretical poles. A pragmatic definition that has been used by previous workers is that

> *'attitude can be described as a learned pre-disposition to respond in a consistently favourable, or unfavourable manner with respect to a given object'* (Fishbein and Ajzen 1975 p3).

This definition is reasonably concise and is useful in that two inferences can be drawn from it. Firstly, attitudes are learnt through interactions, and so are based upon prior exposure. Secondly, attitudes can be viewed as the antecedents to behaviour (Shaw and Wright 1967). Similarly Kiesler et al (1969) suggested that attitudes are complex internal states that affect the choice of action or behaviour towards people, objects or events. Therefore attitudes are likely to be of significance in determining how readily an individual learns, although the relationship has also been shown to be complex (Hill 1985; Curtis et al 2002). In particular initial experiences are powerful and can generate a positive or negative response to a given situation and influence a person's motivation to acquire new skills (Hill 1985; Curtis et al 2002). A favourable or positive attitude generally enhances the motivation to learn and to retain information in a given setting, conversely a negative attitude may impede learning and retention of new information (Henderson et al 1987). This is of direct interest to anyone involved with the implementation of computerised systems within hospital settings. In particular the relationship between nurses and technology is worthy of attention.

Computers have been used in hospital settings since the 1960s (Scarpa et al 1992). It has been suggested that efforts to integrate computers into hospital settings generally have been more successful in the presence of support and strong commitment from hospital administrators and medical staff (Soontit 1987). The role of nursing staff in the implementation process has not been reported in the literature. In a literature review which explored the human factors which influence the introduction of computerised systems, Green et al (1991) agreed that support was important but identified a number of other important factors. They found that training, as previously noted, was important to overcome resistance as was the presence of expert colleagues, but most importantly, the system had to deliver savings in workload, enhance quality and be focussed on the needs of the practitioner. In other words, it must 'deliver the goods', or regardless of the pre-existing attitudes of the staff, negative attitudes and hence resistance will be generated.

When reviewing the literature surrounding attitudes to computerisation, two dimensions of change can be postulated, both of which are relative to time. Firstly, computers in general, and CIS in particular, have become more

sophisticated, capable and user friendly over time (Lenz and Metnitz 1995). This suggests that the exposures which informed attitudes in the 1980s could be expected to be significantly different to experiences formulated within the new millennium and therefore the attitudes which these experiences generate may have changed over time. Secondly, the public in general and nurses in particular are more exposed to computers at home and at work than before, therefore any resistance which was due to unfamiliarity may be lessened (Marasovic et al 1997). The converse is also possible. Not all experiences with computers are happy ones. Indeed although computer failures within the NHS have been reported as being no worse than within the private sector (Smith and Smart 1999), this really is damning with faint praise.

If the experience has been a negative one, the exposure to computers in the clinical environment may formulate hostility. Nurses have been described as being sceptical about using computers. This scepticism may result from negative previous experience with computers and feelings of insecurity and intimidation (Happ 1983). Nurses working within a therapeutic relationship with clients may consider that relationship to be threatened by the de-personalisation often attributed to the use of computers. Sandelowski (1999) also identified that the relationship could be an uneasy one. She suggested that nurses could be viewed in at least two lights. The first, which she described as *'nurses as technology'* (p200) puts forward the idea that nurses could be viewed as a treatment modality, that is a technology, which could be used to promote patient care, suggested in phrases such as the *'physician's right arm.'* The second description put forward was *'technology as nurse'* (p202). This described the possibility of technology replacing function, for example the use of video systems to replace nurse observation. With these precepts, it would be unsurprising if problems with the application of technology were not reported within the literature (Brennan and Romano 1987).

Resistance to IT

In a survey of 40 hospitals with computer systems in place, Dowling (1980) determined that the probability of staff interference was high. This interference was identified as being expressed through passive resistance, verbal expression of dissatisfaction with the system, reluctance to learn to operate

the system, sabotage of data, and refusal to use the system. Timmons and Millar (2002) subsequently identified that resistance would often be exhibited with considerable subtlety, so that the system was used in a less than optimal way, rather than being overtly rejected. In addition, Gibson and Rose (1986) identified anxieties related to returning to the role of the student during the process of learning to use the computer, fear of failure in mastering a new skill, and the perception that computers are a threat to job security. The fraught nature of the relationship was further demonstrated by Barnard and Gerber (1998). Using twenty interviews based upon phenomenological methods, they found that the subjects reported that the application of technology resulted in an alteration and limitation to the free will of the nurse. Clearly the road to successful application of computerised systems is a thorny one. However, the literature also provides some positive examples. Fairman and D'Antonio (1999) suggest that technology can be viewed positively as part of a process of care, in other words that it can be viewed as a system of tools with which nurses can expedite their work.

A number of authors have identified nurse resistance as a major cause of failure of IT systems to either be implemented or properly used (Gibson and Rose 1986; Avila and *Shabot 1989; Badura 1980; Timmons and Millar 2002).* A variety of reasons have been put forward for this phenomenon. Computers can be threatening. Many nurses have spent years developing and expanding their nursing skills and are justifiably proud of their complex practice. Faced with the introduction of computers they must return to the role of the learner again to master a new skill. Additionally some nurses may have fear of failure related to previous bad experiences (Worthley 1982). Gibson and Rose (1986) cite other reasons. For example they hypothesise that a significant component of job satisfaction derives from the opportunity to interact and communicate with co-workers and patients. Removing these social benefits could cause dissatisfaction. This would be enhanced by a socially acceptable attitude of animosity towards these machines.

Studies from outside the context of nursing have also suggested that resistance is complex, widespread and resistant to analysis (Swanson 1974; Kling 1980). It has been specifically noted in both banking and utility companies (Timmons and Miller 2002). In general poor management of the

change process has been identified as a cause of IT failures and this has been associated with limited account being taken of cultural beliefs, norms and values (Bloomfield and Vurdubakis 1995). Without this being considered, implementations of computerised systems are seen as hostile and threats to the *status quo.* In particular, gender has been highlighted amongst business cultures. However, a number of authors including Wright and Ramsay (2000) and Ball and Wilson (2000) identify that it is not only gender in isolation which predicts resistance to, or acceptance of, computers within the workplace, but it is also a construct of the social context of the workplace. Thus within a workplace a prevailing culture may exist which pre-determines that the adoption of IT is seen as a masculine trait. This means that woman may be doubly disadvantaged, both in instilled and experienced aspects of resistance. This discussion is relevant to this project, suggesting that the context of the workplace is an important issue, therefore research methods which maintain context will be desirable.

Whatever the sources of dissatisfaction, computer resistance amongst nurses has been documented, with some sophisticated resistance responses identified. These even include sabotage (Dowling 1980). Why should this be the case amongst highly skilled and otherwise well motivated professional health care practitioners? A novel suggestion is that the paradigm surrounding IT implementations needs to be shifted.

All these authors have posed the question: why do nurses resist computerised systems? This suggests that the onus or duty is upon the nurses to accept the systems. However it remains rather unclear exactly *why* they should do so, apart presumably from the fact that someone has spent large sums of money on buying a new machine. However this in itself is not sufficient reason for acceptance. It is always possible that the nurses resisted the system because it was awful. As Phillips (1993) states, unless these systems enhance the status of nurses within the multidisciplinary team and unless they support patient care, they *should* be rejected!

This then generates the converse question: why should nurses accept computerised systems? If this change in perspective is accepted, the picture becomes markedly different. Firstly, what is it that nurses wish to achieve? If we accept Cody's (1998) work which identified the value to nurses of 'being

with' their patients, then items such as communication that is supportive and reassuring, which focuses on the patient's needs and wishes and the promotion of holistic care with a patient centred focus become valuable achievements in practice development. These findings reveal an enormous gulf between the aims of the implementers of CIS (who may also be nurses but more often are not) and the sources of satisfaction for the nurses. For example Staggers (1998) reviewed a number of research articles investigating the use of computers within health care. She found that the benefits included improved completeness of records, improved quality and number of nursing observations and increased legibility of the patient record. Although it is hard to imagine a nurse who would not be broadly supportive of these aims, it is as if the two different groups are using two distinct languages. The 'implementers' are putting forward mechanistic goals whilst the bedside nurses are focusing on the ways in which they care for their patients, an effect also previously noted by Garmer et al (2002). It may simply be that for a significant group of nurses, the time and energy involved in the change process is not worth the limited augmentation of their preferred role which it offers.

Furthermore, there are good reasons for *not* implementing IT systems (Bawden and Blakeman 1990). Firstly, they are expensive and may not work. For example the Wessex region of the NHS has been reported as having wasted up to £63,000,000 in a ten year program to perform a major upgrade of its information systems. This is only first amongst equals in a long list of wasteful IT initiatives in the public sector (Riley 1995). Secondly, the strategy may be impossible: the implementation may fail due to resistance, hardware and or software problems. Thirdly, it may not be necessary. The 24 hour chart undoubtedly possesses flaws (Millholland 1988), but similarly has strengths (Gordon 1986). Critical care units have evolved over the last 40 years, as has their documentation and it would be unreasonable to summarily dismiss a tried and proven documentation system without a thorough analysis of its positive qualities. Manual systems may be so efficient that they will not be improved by computerisation. It is also often the case that inefficient manual systems can be improved by simple changes in procedures rather than the more drastic option of computerisation (Clayton 1987). It might also be worth

considering whether the current system of documentation is being correctly used. As Firth (1985 p14) puts it: *'applying technology to a manual mess only results in a technological mess.'*

Clearly scepticism is warranted when exploring the impact of these systems upon nurses, however cynicism is not. CIS hold out great promise for nurses within critical care. The idea of two languages has already been alluded to. A well implemented CIS has the possibility of satisfying both sets of speakers. For the technologically minded, database functions and improved patient data recording can be achieved, but more importantly there is the possibility of both freeing the nurse from time consuming and repetitive paperwork and for providing the accurate data that are required to deliver the goal of high quality, patient focussed, nursing care.

Nurses' attitudes to computerisation: the generalised literature

This section will review the literature surrounding nurses' attitudes within two chronologically arranged sections. It will focus firstly upon nurses' attitudes to computing in general and will then apply any insights gained from this to the literature relevant to critical care nurses and their clinical environment.

In 1985, Stronge and Brodt developed their own research tool to explore nurses' attitudes towards computerisation. This piece of work will be used as the point of departure for this section. This decision, although to some extent arbitrary, was based upon three factors. Firstly, at some point in the mid 1980s, it could be argued that computers were beginning to impact on everyday life and the widespread adoption of software such as Microsoft's Windows resulted in systems that although changed and refined, remain recognisable 18 years later. Therefore, this is one of the earliest pieces of work which could be realistically described as comparing like with like. Secondly, Stronge and Brodt (1985) built the content of the questionnaire that they used upon earlier work, dating back to the work of Reznikoff et al (1967). It could be argued that their investigation therefore contains elements of summation of the earlier workers' studies. Lastly, Stronge and Brodt's (1985) methodology was used at three further sites, once by the same authors and twice by independent workers, and these three pieces taken together represent a solid and scholarly attempt to explore this topic. The results from

the three studies will be noted sequentially, and then analysed in a concluding discussion.

Stronge and Brodt (1985) used a Likert scale. To construct this they conducted a literature search and identified six major issues which were of concern to nurses. These were job security, legal issues, the quality of patient care, the capabilities of computers, the willingness of staff to use computers and the benefits to the institution of the systems. From this list, they then derived 66 statements. In order to avoid bias, approximately equal numbers of positive and negative statements were given in random order. The statements were formatted using a five point Likert scale. A pilot group of sixty nursing students was used. Of these, 80% returned the questionnaires. From these 20 final questions were selected using an alpha analysis (Stronge and Brodt 1985).

Although some aspects of the reported methodology were incomplete, the research process chosen appears logical. However, some concerns can be identified over the choice of research tool. Firstly there are issues of concern related to relying solely on a quantitative research method, which have been identified earlier. Secondly, initial summation of a Likert scale results in one mean value being obtained from the data set. However, as discussed earlier, there is a significant body of evidence which suggests that nurses' attitudes are multidimensional and that the data that they provide are conditional and have reactivity (Trochim 2000). By definition this single value cannot represent the complex relationship between the nurses, their patients and their use of computerised systems. Instead, within the Likert data set, statistical techniques such as factor analysis could be used to identify whether different functional groupings of questions were present within the data. Such techniques however were not used and so the results presented may represent an oversimplification of the data set.

In addition, concerns can be expressed over some of the individual items within the Likert scale. For example, Stronge and Brodt's (1985) questionnaire uses the statement 'computers make nurses' jobs easier.' Bearing in mind the complexity of nursing, this may actually involve a number of issues (or dimensions). For example, the computers may make charting simpler, clearer or more timely, but may be of little or no help in administering pain

relief or sedation to an acutely distressed patient. The response to this item cannot then cover both dimensions, and the result obtained will depend upon the values of the nurse completing it. Therefore the result, far from being objective, becomes a subjective one.

In 1986, the same authors used their tool with a group of 225 nurses who worked in a community hospital in the Midwest USA (Brodt and Stronge 1986). Although not specified, this appears to have been an inclusive sample. Eight null hypotheses were proposed based upon educational preparation, gender, age, length of employment in the institution, length of service in the nursing profession, shifts of duty worked, daily interaction with a computer terminal and types of nursing units. A one way analysis of variance was used to explore the data. Significance to disprove an hypothesis was maintained at $p<0.05$. Of the eight null hypotheses put forward three were rejected. Firstly it was found that the higher the academic level at which the nurses had studied, the more positive the attitude to computers. Secondly, and perhaps contrary to preconception, it was found that nurses who had worked longer than 21 years were more in favour of computers than those who had worked less than ten years. Thirdly, nurses working in different units had differing attitudes towards computerisation. Unfortunately it was not possible to analyse this in terms of an acute/chronic axis, which might have been of direct relevance to this project. This is because the groups, paediatric rehabilitation and nursing administration, which were more favourable to computerisation than medical and surgical nurses are not readily compatible with UK specialities. In application to this project then, the results which can be identified as being of direct relevance, are that the higher the educational achievement and the longer the period of service, the more likely is the nurse to be favourable to the implementation of computers in the clinical area. What did the other groups who used this tool identify, and can their results provide a more sustained analysis?

In 1988 Bongartz used Stronge and Brodt's (1985) tool to investigate three areas of study. Firstly, to survey the attitudes of nurses towards computerisation through the use of a valid and reliable instrument. Secondly to compare attitudes between two groups of nurses, those who had experiences of computers in the clinical area, and those who did not, and

thirdly to gain insight into how nurses perceive the influence of computers on nurses roles and the nursing profession. Although these are laudable aims, the choice of tool remains suspect. Firstly, although the accolade of reliability may be sustainable, that of validity has limited support. Bongartz (1998) is also unclear as to what is meant by 'gaining insight.' If this term is meant as an exploration of the nurses' values relating to the use of computers, a case can be made for employing inductive measures rather than relying on a prescriptive Likert scale (Polit et al 2001).

The study took place within two city hospitals in the USA. One hospital had used computers on their wards for several years, the other had not. Items within the computer provision included: order entry (this category is not explained further), retrieval of test results, medication administration lists and nurse care planning. As such, the system employed includes some attributes of current CIS.

Questionnaires were administered to 726 nurses at the 'user' hospital and 483 at the 'non user' hospital. The selection strategy used for sampling was not included, however due to the large numbers, it seems likely that these were inclusive samples. Completion of questionnaires was recorded as 60.6% and 57.3% respectively. A *t*-test was used to compare samples. All results were assessed at $p<0.05$. The study suggested that the non user group felt significantly more positive that computers could allow nurses more time to give to direct nursing care. Secondly, the non user group had a significantly more positive attitude towards the capabilities of the computers. Non users were found to be more willing to use computers and felt that the computers could enhance patient care. There were no significant differences noted between the other aspects of the questionnaire. Both groups perceived the computer as a source of error reduction in documentation and did not believe that patient privacy would be violated. In general, therefore, the findings from Bongartz's (1988) study suggest that the non user group were more positively orientated towards the use of the computer than the users.

A pragmatic analysis might be as follows. The group who were users of the computerised system were less enthusiastic because having used the system, they found it to be less helpful than they (as indicated by the results of the non user group) had hoped. This is reflected in Bongartz's (1988) conclusion, that

the research showed that the implementation within the study hospital was evaluated as not meeting the nurses' needs. Bongartz (1988) put forward reasons to explain this, by suggesting this may be due to a lack of understanding of the capabilities of the computer and of the duplication of paperwork, however cites no reason to support this. This may represent another example of *post hoc* pro-computer bias.

In 1992 Scarpa et al used the same tool. Their sample consisted of 335 nurses in a hospital which did not use computers in the clinical area. The overall response rate was 40.6%. Results were tested using analysis of variance and un-paired *t*-tests. In addition, a descriptive analysis was also discussed. Scarpa et al (1992) reported that their findings were congruent with the previous studies. They found that in general the nurses were weakly positive about the impact of computers. Of the variables examined, previous experience with computers was the only one significantly related to positive attitudes. Job title, level of education, age and years of nursing experience did little to predict nurses' attitudes towards computers.

Taken together, what do these studies show? All three suggest that nurses in the period 1986-1992 were positive to the use of computers. Mean scores fell within the range 70.1 to 72.2 (maximum score of 100). This small range suggests that the study tool was reliable, a finding supported by Stockton and Verhey (1995) who examined the internal reliability of the questionnaire. In addition to being generally favourable, Brodt and Stronge (1986) found that the older and more experienced the nurses were, the more positively they felt towards computers, but this was not supported by the other two studies. Similarly Scarpa (1992) found that previous exposure meant that nurses were more positive towards computerisation, but this was directly in contradiction to Bongartz's (1988) findings. Brodt and Stronge (1986) found that the higher the level of education the more positive the nurses' attitudes were, however this correlation was not identified in the other studies. Finally, Scarpa et al (1992) did find that the more senior the nurses were, the more positively they felt towards computers. Therefore these two findings, to some extent, support each other.

The questionnaires used by these three studies produced some interesting data. However, it is debatable whether these earnest and statistically exacting

studies really moved the debate forwards. In particular relying solely on a Likert scale to address such a complex issue as attitudes towards computerisation is of concern. This is because the scale is prescriptive i.e. only items within the scale can be chosen and rated. In addition, Likert scales are essentially deductive in design. Stronge and Brodt (1985) based theirs upon theoretical components derived from a literature search. There is however no evidence either that the literature search was exhaustive, or that their analysis of it was free from bias. Thus the statements chosen for use within the scale are likely to be limited in their ability to explore the nurses' full range of attitudes to computers. To counteract this effect, it can be suggested that inclusion of an inductive element would have been desirable. This would have potentially allowed novel findings to be identified, firstly for comparison with the quantitative elements and secondly for producing additional theory. This could have enriched the research, a strategy adopted by Kaplan and Duchon 1988 and Yin 1994. In addition, all three teams of researchers used the same tool, therefore any bias included would be repeated and given cumulative weighting. Perhaps this analysis is too harsh. Likert scales are well established as research methods. However, using the Likert scale on its own without support from other sources may be unwise.

In 1994 two further publications focussed the study of nurses' attitudes on to the intensive care environment within the UK (Large 1994; Lowry 1994). On a positive note, both studies depart from the above in that different tools were used, which raises the possibility of comparison between different sources. However, both were again deductive in design and so this is likely to limit the breadth of response, which would be of particular interest in this research project. This is particularly true when considering the first research question (page 10), which is highly inductive in nature.

Large (1994) conducted his study on a group of 30 intensive care nurses at Glenfield Hospital in Leicester. Three null hypotheses were selected, covering the ability of computers to directly enhance care, indirectly enhance patient care or result in greater patient contact. Three simple positive statements were used to reflect these hypotheses using a three point Likert scale. Questionnaires were analysed using the Kolmogorov-Smirnov test. This is a form of *chi* squared test for the analysis of ordinal data that is suitable for

analysing goodness of fit. It tests the frequency distribution of the observed result against the expected one, usually based upon a normal distribution (Reid and Boore 1987).

The study describes the distribution of questionnaires as being random, but in fact the method has more of the qualities of a convenience sample: the questionnaires were distributed on shifts until all 30 had been given. All grades were represented and a return rate of 100% reported. This extraordinarily high figure raises two issues. Firstly, it shows the advantages of being a senior nurse involved in research on your own unit, whereby the full co-operation of your staff is assured. However there is a possible adverse aspect. If the interests and enthusiasms of the researcher were known, bias may be introduced to the sample, as junior staff may wish to please the senior member. This could be interpreted as an extension of the Hawthorne effect (Polit et al 2001). Taken in conjunction with the small sample size, this is another factor which emphasises caution in the acceptance of the study findings. A significance level of $p< 0.05$ was set.

The results showed a strong agreement with the statement that computers can *indirectly* enhance patient care. The second statement suggested that computers can *directly* enhance patient. The response was equivocal, with seven agreeing, 15 remaining neutral and eight disagreeing. These responses were statistically not significant, therefore this statement was not accepted. The third statement inferred that the use of computers allowed the nurses more time at the bedside. Although 14 out of 30 agreed, this was not a statistically significant result, therefore this statement was also not accepted.

What does Large's (1994) study suggest? Whatever is concluded from the study is subject to three limitations. Firstly the data are quantitative and this once again limits the depth of interpretation from the data. Secondly, the sample size is small and possibly prone to bias. Thirdly reliability and validity are not discussed within the research publication. Despite all these limitations, some interesting issues still remain. Firstly, the nurses identified their belief that computers could indirectly support the care which they deliver to their patients. However, they did not believe that the computers could do this either by liberating nursing time or by directly influencing the care they deliver. Large concludes that because technology is prevalent within this clinical area the

nurses were able to identify the links with patient care, but were also sceptical about the ways in which they could be directly supported. It is also interesting that the nurses did not feel that the computers could liberate nursing time, since this a claim made by the promulgators of many computerised systems (Duce and Harris 1990; Lenz and Metnitz 1995, amongst others), but which has never been proven. Perhaps the nurses are wise to be sceptical of this aspect. Despite this scepticism, the overall scores of the study show the nurses to be generally positive towards computers in critical care, a result which corroborates well with the studies which used Stronge and Brodt's (1995) questionnaire.

In the final study to be analysed, Lowry (1994) chose to focus on a particular aspect of IT, this was the ability of computers to support care planning within critical care. This activity falls within the remit of current CIS and so is legitimately relevant to this thesis. She chose seven null hypotheses to explore attitude with reference to demographic items such as association between clinical grade, age, education, full time or part time status, number of years qualified, number of years worked and previous experience and attitude.

The study used an inclusive sample taken from a general intensive care unit in Belfast, Northern Ireland, consisting of 54 nurses of all grades. Following a pilot study, a two part questionnaire was compiled, using closed questions. The first part of the questionnaire gathered demographic details and the second part contained ten attitude statements, again using a five point Likert scale. The attitude statements covered time management, individualisation of the care planning, time available to carry out patient care, confidentiality, autonomy, quality of documentation, the implementation of research and the ability of nurses to set their own standards of care. Although it is reported that ten attitude statements were used, only nine were listed in the article.

One way analysis of variance was used to test the scores. The significance level was set at $p<0.05$. Given a maximum possible mean score of 50, the mean score of the respondents was 32.8, with a standard deviation of 4.8. Therefore, in line with all the other studies, nurses appear to be generally positive towards the use of computers. The null hypotheses were supported

for analysis by clinical grade and education. It was reported that the younger the staff had the most favourable attitudes. This finding partially contradicts the work of Stronge and Brodt (1994), who found that staff who had been qualified more than 21 years were significantly more enthusiastic than those qualified less than ten, whereas Lowry's (1994) study identified a time frame of seven years: those qualified and working for less than seven years being more positive. The null hypothesis was supported for educational achievement (again in contradiction to Stronge and Brodt 1994), although to give context to this, at the time of the study only one respondent possessed a diploma, and no respondents possessed a degree. This degree of academic attainment would be greatly changed within UK critical care units were the research to be carried out today. For approximately the last decade most nurses within the UK have qualified with either a diploma or degree. Therefore the findings of Stronge and Brodt (1994) paradoxically might be more relevant to modern UK nursing, despite coming from the USA.

Attitudes: conclusions

Taken together these studies represent a large volume of data. The only finding common to all the studies was that nurses were generally positive to using computers. Broadly, all other findings from the studies were very neatly negated by comparison within the cohort. At first glance then, a lot of effort resulted in disappointingly anodyne findings. However, within the mundane nature of these findings lies an important finding. It can be argued that more sensitive and detailed information could have been obtained by the addition of qualitative data such as interviews or focus groups. However, what might not have been delivered was the broad sweep of these findings. In essence, nurses were generally positive towards the roles of computers, *especially when they had not used them previously.*

What do nurses want?

If nurses are disappointed in what CIS provide, it suggests that the systems do not deliver what the nurses want. Logically therefore, the next issue is to explore what nurses want from these systems. However there is no qualitative information which meets the literature review criteria to explore this. What *is* available however, is some evidence which identifies aspects of nursing which nurses see as being rewarding in terms of the care they deliver. From this it

might be possible to infer the desirable features for nurses which CIS could posses.

Cody (1998) used a phenomenological analysis of seven nurse narratives to investigate nurses' perceptions of what comprised good nursing care. Overwhelmingly they reported communication to be a central issue. Echoing the first chapter of this work, they interpreted quality care as 'being with' patients rather than delivering technical care, a position broadly supported by Hardy et al (2002). It was also suggested that the multifaceted nature of critical care nursing could be overwhelming and might make too many demands on nurses. This is supported more generally within the broader nursing literature (Hudak 1994; Nelms 1996; Marshall 1995; Chant et al 2002).

If nursing is caring, that caring has different levels. Using Norrie's (1997b) five-fold categorisation of nurse activity, if the computerised system can help nurses deal with the clerical or assessment requirements of the patients, then there is the possibility of allowing the nurses to focus more clearly on the rewarding aspects of care: 'being there' (Cody 1998), or in Norrie's (1997b) terms, delivering 'direct patient care', either through the computerised system directly carrying out functions such as the monitoring and recording of physiological functions, or indirectly through liberating nursing time.

The *tabula rasa*

This discussion and the information gained from the various quantitative studies into attitude allows the construction of a hypothesis. Prior to exposure within the clinical area, nurses seem to be generally positive that computerised systems will be supportive to their needs. However they will become less enthusiastic after exposure to systems which are less than ideal, or conversely they will become more enthusiastic after exposure to systems which support their nursing care. The worth of the systems to which they have already been exposed can be judged from the previous review. It can be hypothesised therefore that nurses, prior to exposure, represent a *tabula rasa* (a smoothed or blank tablet receptive to impression) and it is the early exposures to computerised systems within the clinical area which determine their subsequent attitudes.

This may be reasonable but a linear relationship between the system and the nurse seems oversimplified. The relationship will always be more complex. The nurse functions under a variety of pressures which can affect the relationship. The computer system will never be in a position to actively support all aspects of the nurses' care and no matter how sophisticated the system is, it can realistically be expected to help some aspects of nursing care and hinder others. This is a similar argument to Trochim's (2000) concept of dimensionality. There is a valuable point to be found within this discussion which might benefit from being openly stated.

It should be stressed that it is the *nurses'* expectations (rather than medical staff or administrators) of the systems which are the central issue to formation of positive attitudes. However, in the previous chapters, it was identified that CIS have been constructed and implemented by groups who have different agendas. The tendency has been paternalistic: systems have been developed *for* nurses, *by* manufacturers, *by* medical staff and *by* administrators, rather than *with* nurses. Therefore it is entirely possible that an implementation could be described as being wholly successful because it was (for example) particularly cost effective, or it allowed accurate medical review, or because it proved to be entirely reliable, but because it did not support the nurses in delivering the aspects of nursing care which *they* valued, it would not be able to make a positive impression on the *tabula rasa* and therefore would never find support amongst the most important group of users: the nurses at the bedside. This perspective is valuable when considering the implementation of current innovations such as the integrated care record systems within the NHS, where record keeping will be electronic and multi professional (NHS Information Authority 2003). Similarly nurses will be involved in the electronic patient record and electronic health record (Brennan 2000). The inference that can be drawn form this discussion is that the needs of all the professions involved will need to be addressed for the process to proceed optimally.

The evidence from further afield

If the case for persisting with CIS is accepted, what can be learnt from case studies which might be of value in the research project? The literature on CIS has already been explored and was found lacking in methodology and outcome. Therefore a number of case study reports were examined looking

beyond the impact of CIS on nurses within the acute hospital setting. The three studies identified using the literature review criteria on page 15 will now be briefly reviewed in chronological order, with the intention of identifying commonalties which can identify theory which might be useful during data analysis. It is interesting to note that in comparison with the research which investigated the use of CIS within the acute setting, these studies all contained qualitative investigations, indeed two were entirely qualitative and one used a mixed methodology structure.

Firstly, Barley (1986) examined what happened in two hospitals in Massachusetts, USA in the early 1980s when new Computerised Tomography (CT) scanners were introduced into their radiology departments. There is one feature of the workers within the radiology departments in this study which is particularly interesting for this research project. There were two groups of professionals involved in the process of obtaining CT scans. These were radiologists and radiological technologists. Barley (1986) notes that traditionally the medically qualified radiologists had dominated the technologists. The technologists, although of graduate status and highly trained in running the machines within the department, were not educated in diagnosis from the tests which they conduct. This pattern of expertise created a hierarchy of authority in which radiologists knew what technologists knew, but not necessarily the reverse (Barley 1986). This division of labour and knowledge is reminiscent of the relationship between nurses and medical staff in critical care, where the medical staff prescribe and the nurses deliver the often technically demanding care that the patients require (Manley 1994). Barley (1986) notes that the radiologists seldom achieve the manual finesse of the technologists, and to some extent this is also true of the two groups of critical care workers.

Barley (1986) used extensive qualitative fieldwork to observe the interactions which took place between users of the equipment. The fieldwork covered 400 patient observations and data were recorded as both field notes and tape recordings. A rather complex system of data analysis was used, which broadly broke down into three stages. In stage one, examples were identified where working practices abruptly changed ('breakpoints') and roles were realigned in order to use the new technology. The second stage was to

analyse the interactions which took place between workers to identify the characteristics of each group. The third and final analysis linked the first two stages to the formal structure of the clinical areas. To summarise a very painstaking and erudite piece of work, Barley (1986) found that the introduction of the new technology resulted in a restructuring of the work within the radiology unit and of the relationships between the two groups of workers. However despite introduction of two identical machines at the two research sites, different working practices resulted, one described as being centralised and one as decentralised. This meant that at the former a more hierarchical (or traditional) pattern of working evolved, whereas at the latter there was a more balanced sharing of information and expertise. This is very important for the nurses who would work with CIS. It suggests that the implementation of new technology will give the opportunity for changes in the structuring of workload within the critical care environment. Barley (1986) reports that this is due to increasing complexity, making roles less certain and forcing workers to rely more upon each other, blurring the traditional roles of the two groups. It shows that it is not the technology itself that is the determinant factor in the nature of the redistribution of work, rather it is the interaction between the groups of workers who are involved in its implementation. In other words, the implementation of a new piece of technology is an opportunity for the workers within the field to develop new practice. It can be hypothesised therefore that for a change to be of value to the nurses within the critical care environment, it is fundamental that they are co-authors of the system so that as the new boundaries of practice are redefined the new working practices support their aspirations.

In 1988 Kaplan and Duchon used a mix of quantitative and qualitative methods to explore the computerisation of a clinical laboratory. Within the article a strong case was put forward for combining these methods in order to provide reliable data. The stated aim was to research what happened when a computer information system was installed into a new setting. The system used had been implemented in a number of previous settings, and *was 'well respected'* (Kaplan and Duchon 1988 p575). A research team was inaugurated and three investigative strands outlined: interviews, observations and questionnaires.

The interviews included as subjects the senior figures within the laboratory, in order to determine potential effects and to generate questionnaire items. The observations took place during meetings of the laboratory management group. In applicability to this research project, this focus is somewhat disappointing. It is unclear why the authors chose to concentrate on the managers of the laboratories, rather than the workers who would be using the system on a daily basis. In some ways this is reminiscent of the quantitative CIS studies, where the expectations of the researchers (primarily managers and senior medical staff) were imposed upon the nurses who regularly used the system. A questionnaire was developed from these data which examined job characteristics, role conflict and roles within the team. A mix of Likert scale and open ended questions was used. The questionnaire was piloted and delivered to all 248 members of the laboratory staff seven months after the computerised system was implemented.

The open ended questions produced three main themes. These were changes in workload, improvement in results reporting, and the need for the nurses and physicians involved to use the computer terminals rather than telephoning for results. The findings within these three categories were that there was a general agreement that clerical duties and paperwork had increased and that productivity had suffered. However the system was credited with making results more available, complete and accurate. Despite the introduction of a computerised system within the clinical area, both doctors and nurses still expected to get results by telephone, and the technicians found that they were being blamed for problems caused by the computer system.

What implications do these findings have for nurses within critical care? Firstly the dogma of computerised systems, that they can save time, remains unsupported and indeed the opposite is reported: these systems can subjectively increase workload (Kaplan and Duchon 1988). This is a serious indictment of the systems when transferred to the critical care environment, where the nurses are hard pressed for time and desire less time to be spent on paperwork and documentation and more to be spent on patient care (Norrie 1997b). This would make the systems much less acceptable to nurses and would undoubtedly promote nurse resistance. However, the system did

appear to result in more accurate results being produced. This is an important finding, but with limitations within the nursing arena. The *raison d'être* for clinical laboratories is to produce accurate results. Therefore in terms of Duchon and Kaplan's (1988) research setting this is an important result. However, the *raison d'être* for critical care nurses is not to produce accurate results or data, rather these are tools which can support the real principal aim, to provide good quality care for patients. This is an example of the 'two language' debate, speculated upon earlier. Although the production of accurate records is undoubtedly a positive feature, it is unclear whether this is such a significant goal for nurses that it will help overcome any innate resistance that they have or express. Again, two languages are being used. The final point is also interesting and relevant. Despite the system allowing direct access from computer terminals, the medical and nursing staff were reported as consistently preferring to telephone for results. There are a number of possible reasons for this. For example the terminals within the clinical areas might not have been amenable to use and might have been either time consuming or technically challenging for the staff, it would therefore be easier to telephone. Another explanation would take into account the quality of the communication. Nurses spend a lot of time in communication with colleagues, clients and relatives. Indeed communication has been described as being fundamental to nursing (Crawford et al 1998). Such communication has been described as containing both verbal and non-verbal components (French 1994). Nurses therefore are used to and are skilled in high quality communication. When accessing results through a computer monitor within the clinical area, they will be deprived of both these aspects of communication, therefore it is possible that this represents a disincentive for acceptance of a computerised system, in that at least with a telephone call, verbal communication is established between the parties involved. This is potentially important in the implementation of CIS, where nurses will be the main interrogators of the systems, especially if the quality of person to person communication becomes impoverished.

It can be seen that the qualitative strand of the research yielded a mix of positive and negative findings related to the computerised system and it can be argued that the main positive finding, that of increased accuracy, would in

fact be of low significance for nurses. Responses to the Likert scale items produced findings with some similarities, but some differences too. It found that the results reporting system had improved, as had communications within the laboratories. However unlike the qualitative strand it did not suggest that the number of phone calls and the amount of work had increased nor that the laboratory staff co-operated less with physicians and nurses. The apparent contrasts between the two sets of data prompted the researchers to re-evaluate their field notes and analyses of the data. What they proposed was that within the sample there were two discrete populations. The first group emphasised their work in terms of producing results reports, the second group emphasised the laboratory bench work necessary to produce these reports. The disparity in findings between the two research measures depended upon which of these was valued as being most important by the worker. It is difficult to translate this finding into terms directly applicable to nursing.

However it does raise an important point. It is often assumed that target populations are homogenous in nature, but Kaplan and Duchon (1988) identified that their sample was heterogeneous, with different populations using different criteria to judge the effectiveness of the computerised system. This suggests that responses within a critical care area to a CIS would similarly be heterogeneous and might be related to a number of unspecified component populations. For example, nurses in the UK have different clinical grading related to clinical skills, length of time in service, and managerial roles. Each one of the clinical grades may have a different agenda and would therefore evaluate the system using different criteria. Furthermore, even within each grade different populations may exist. Therefore any analysis of data concerning the implementation of a CIS would have to take this multiplicity of perspectives into account, otherwise what would result would be an oversimplification with a loss of important detail, and this perspective is commended for the research design.

The final case study to be reviewed concerns the implementation of a HIS in an unnamed English town hospital (Currie and Brown 1997). This is a unique report in that it details a 'failed' IT project, although the definition of 'failure' is not given. It is a slightly odd admission to make, in that the system was implemented and had been running for at least 18 months at the time of

the report writing. What the authors seem to suggest is that although the system was physically in operation, the implementation failed on two counts. Firstly the project team which planned the system and implemented it lost control, hence there was a failure of management of the project and secondly, due to resistance to the system there was a failure to use the system optimally and to accept it.

The authors describe their research as being ethnographical in structure, in that they were immersed in the project for implementing the HIS, although they do not provide information as to their own roles. Given that much of the discussion is concerned with the tension between the different groups involved in the implementation, this is a limitation to the research possibly introducing bias. The majority of the data were spoken language although the authors also mention a total of twenty six interviews.

The background to the case study was the acquisition of a HIS which could be configured to meet the needs of all the hospital environments. It was perceived that the haematology laboratory was a priority area for the HIS since this produced a large amount of data which would be accessed throughout the hospital. The point of departure was when problems started to arise for the project team, and from this Currie and Brown (1997) constructed two narratives: the haematology narrative and the project team narrative.

In the haematology narrative it was identified that one of the reasons the consultant in charge of the laboratory wanted to be involved in the early stages of the implementation was to create a future in which the existing work patterns would be preserved, as would the already rather aged laboratory computer system. In other words, the change to the HIS was embraced in order to minimise the change to working practices! An important factor which influenced this was the strength of personality of the senior haematologists who imposed conditions upon the project team. Communications between the two groups deteriorated and understanding of the pressures on either side was limited. Junior laboratory staff added a further dimension to the story by reporting that 'most..... liaison occurred at senior levels, but ..... the senior staff were too far removed from the day to day operation of the laboratory' (p72).

The project team narrative revealed that they too were having an unhappy time. It was felt that the consultant haematologist through *'position power, force of personality, and skill in networking and negotiation'* (p 72) was able to substantially alter the course of a major IT implementation. In addition the project team was torn further, in that the software company became increasingly secretive and delivered their preferred technical solutions rather than the preferred solutions of the project team. The project team was rendered relatively powerless and what resulted was a system that disappointed those that used it and was not accepted by any of the stakeholders.

What can be learnt from this case study? The authors suggest that personalities are powerful. In terms of CIS implementations within critical care, it is likely that consultant medical staff would retain their power as the most influential figures within clinical areas, resulting in an imbalance between the major users of the systems (the nurses) and the major promulgators of the systems (the consultants). Currie and Brown (1997) use two theoretical constructs to explore what took place, that of 'licence' and 'charter.' They suggest that with licence, occupational philosophies are carried into organisations. Charter in contrast can be said to represent constraints on a persons freedom of action that he or she depicts as exterior objective or given (Hughes 1971). Thus the consultant haematologist used his powerful hierarchical licence to impose the existing working practices onto the HIS project and evidently did not feel constrained by the institutional charter. This suggests a refinement of Barley's (1986) findings which showed that the implementation of new technology was an opportunity for restructuring work practices, and that the changes that resulted were not directly dependant on the technology itself. It suggests that the ability of the medical staff to exercise their powerful licence and their relative ability not to be inhibited by institutional charter could result in a skewing in their favour of any renegotiating of work practices following implementation of a CIS. In addition, the negotiation will be influenced by the oligarchic nature of the consultancy within a critical care unit, because strong personalities carry weight.

These are interesting concepts because for nurses the converse is commonly true: licence is often limited, and their charter is a heavily

constraining force. This is evidence for this in the debate over patient advocacy within nursing. Nurses are obliged to act as patient advocates and so they could be said to have a licence for this function, yet they are severely constrained by the organisations within which they work against doing so (Casteldine 1981, Norrie 1997a) and so their charter is limited, creating a tension. These two concepts are useful because they define the variables that in the past may have made nurses passive to the implementation of computerised systems.

In summary, these studies suggest that when a system is introduced, the changes in work practice are plastic and are to some extent open to negotiation, which will be influenced by the institutional and personal characteristics of the parties who are involved. It is therefore important to explore some of the issues that will influence the process of negotiation and realignment of roles. Licence and charter suggest that the medical staff may have the upper hand in this process.

Factors which affect nurses' charter

One issue which must be considered when looking at the balance of power is that of gender, since nursing remains a predominantly female profession (Jolly 1995). It is not within the remit of this chapter to perform an extensive analysis of gender issues within the clinical environment, rather what is intended is to identify issues that may be relevant in the understanding of roles and in the analysis of data that may be yielded by fieldwork.

Nursing exhibits many behaviours typical of oppressed minorities. For example Osborne (1991) argues that all oppressed groups develop emotional mechanisms to cope with their relative powerlessness. These include heightened awareness of other peoples' emotional states, and a blurring of the boundaries between self and others. As a result, the oppressed community become specialists in relationships and in mediation (Miers 2000). Indeed, nurses have made a virtue of these qualities as they are an important part of the caring process. It has been argued that of all the professions subject to sex-role stereotyping, nurses are amongst the most severely handicapped, as they are doubly conditioned, by society and the medical profession to be deferential and obedient, rather than assertively taking control of their destiny (Pizurky et al 1987). Greaves (1996) identified a

number of limitations on the ways in which nurses develop their roles by a patriarchal society. Three of these, education, attitudes to science and technology and the dominance of a male medical profession will be discussed as they have relevance to the use of IT within the clinical area.

There is a relationship between women's educational experience and that of qualified nurses. Greaves (1996) found that scientific disciplines are not encouraged for girls during schooling and particularly technology and computing were promoted amongst boys, but not girls, despite boys and girls being roughly similar in terms of academic achievement. Greaves (1996) suggests that this difference is lived out in women's lives as a *'mental set of inferiority and rejection of technology which becomes a self fulfilling prophecy'* (p 195). Both these arguments are potentially important to nurses within the critical care environment. If these tenets are accepted, it could be proposed that on the one hand the nurses will tend to develop their empathetic skills (for which they are applauded), whilst on the other hand they may tend to shy away from the technology which is present within the clinical area. Both aspects might be expected to make nurses less acceptant of CIS.

There are limitations to this analysis however. Firstly, it has already been identified that to treat the nurses, or indeed any group of women, within any given clinical area as an homogenous group is simplistic (Trauth 2002; Wilson 2002). Nurses are clearly a heterogeneous group, with many different aptitudes. Therefore their attitudes towards technology will comprise a corresponding diversity. Secondly, not all nurses actually are women! Approximately ten per cent are male (Mackay 1993), and if the argument regarding attitudes to technology and science in schooling holds, they might be expected to be early adopters of any technological changes, and could therefore skew any findings in favour of new practices. Lastly, the critical care area itself is redolent of advanced technology and it seems unlikely that any technophobe would actually choose to work in such an environment. It may be, therefore, that critical care nurses are to some extent self selecting with reference to their attitudes towards technology.

As an alternative argument, it has been suggested that in fact women are ideal candidates for working with computers as this field of work is clean, modern and is not associated with dirty workshops or heavy lifting. However

as computing has developed as a career, there is evidence that it has become increasingly male dominated (Lovegrove 1990). This may be because as the field has grown it has become more exclusively male and dominated by aggressive male power and fascination with technology, and it has been observed in general that when IT has been introduced into clinical areas, nurses have been seen to be ill prepared (Perry and Morhinweg 1992), which does not bode well for CIS implementations.

The final gender related issue to be considered is that of the nurse-doctor relationship. This is important on two levels. Firstly it constitutes an important part of the general environment in which nurses in critical care work: the medical staff are typically the group within the multidisciplinary team with whom the majority of interactions occur. Secondly, all the CIS systems so far identified by fieldwork have been initiated and managed by medical staff. Traditionally medical staff have been predominately male and although that position has changed markedly of late, the profession is still dominated by powerful male figures and culture, to such an extent that even female members of the same profession report stress, sexism and prejudice. Therefore although numerically the medical profession may not be dominated to the same extent by males, it still retains many of the qualities of a male dominated profession (Firth Cozens 1991).

In 1967, Stein observed the way in which nurses and doctors interacted and termed it the 'doctor-nurse game.' In brief he suggested that nurses could influence patient care by making requests in such a way as to make their recommendations appear to be initiated by the doctor. The rules of the game dictated that disagreement must be avoided at all cost: the nurse makes the recommendation without appearing to, and the doctor accepts it without appearing to. Miers (2000) suggests that this game is rooted in the dominant male paternalistic model of medicine which provides licence to exercise authority and to make decisions, resulting in feelings of omnipotence and unwarranted certainty. This set of values was compounded by the strict discipline of nurse training, fear of independent action and (overweening) respect for the medical profession. Clearly, this is an historical piece of work, but it is important in that it represents one extreme of the way in which nurses and doctors work together.

In a later discussion, Stein felt that the position had changed (Stein et al 1990). He reported that one of the players (the nurse) had stopped playing and wanted to change the rules. Clearly something had changed. Certainly feminism had influenced the way in which women viewed their work and conditions. By the mid 1980s feminism had moved out of the universities and had become rooted in a number of workplaces (Mitchell and Oakley 1986). Perhaps it was simply the *zeitgeist* and was reflective of a society which had become less deferential. However, the doctor nurse game is still of interest. For example Timmons and Tredoux (2000) explored the ways in both parties competed for the use of computers within the clinical area. They concluded that because of the asymmetries of power between the two groups, doctors could still get nurses to stop using computers when they wished to use them, but not *vice versa*. Thus the old balance of power, to some extent still exists.

Another set of changes are relevant. Nurses, although an expensive resource, are cheaper and more numerous than doctors. In 1993 there were approximately 500,000 nurses as against 48,000 doctors (Mackay 1993 p48). As medical science has become more technologically advanced, doctors and in particular junior doctors have been faced with more and more work. Who better to delegate this excess to than the nurses? By 1992 a new deal had been put together to reduce the hours that junior doctors worked (DOH 1992). At approximately the same time as the new deal for junior doctors, and (allegedly) by coincidence, the body which controlled the nursing profession, the UKCC, changed the parameters within which nurses worked. Prior to 1992 if nurses wished to develop their roles beyond the skills associated with their basic training, they were said to be 'extending' their roles, and this role extension was sanctioned by more or less relevant medical staff within the clinical area. With the publication of the document 'the Scope of Professional Practice' (UKCC 1992b) the rhetoric changed. The scope of practice within which nurses worked could now be 'expanded' and this role expansion was not predicated by medical staff, but could be generated from within nursing. This renegotiation had profound affects on both professions. Firstly, it acknowledged the abilities and skills of the nurses in that they were now empowered to carry out work that previously only doctors were deemed capable of. It also made the doctors more dependant on nurses and a more

meaningful discussion of team work became viable. Unfortunately, there was also a down side for the nurses: there was a danger that the new deal would mean that the nurses were more responsible to doctors rather than to their own profession and were therefore in peril of moving away from a concept of nursing as an autonomous body of knowledge and practice (Savage 1997).

As Todd and Goodrich (2001) noted, such a new development carries with it risks, particularly the potential threat to the integrity of holistic nursing care. This is addressed within the Scope of Professional Practice document itself which puts forwards six principles by which each nurse should justify any expansion of their role (table 15). The document increases and perhaps uniquely defines the nurses' licence by acknowledging the ability of nurses to adopt many of the roles and skills necessary to care for their patients. Equally it raises the potential for a true partnership with the medical staff, since the nurses can now work from a position of strength, citing a coherent rationale for the roles which they adopt.

Earlier in this discussion the doctor-nurse game was cited, and it was suggested that this represented one extreme in the way in which the two professions work together. It can be suggested that the 'post Scope' nurse working within a true partnership with medical staff represents the other extreme, with a continuum stretched between the two points.

Table 15: Summary of the principles for adjusting the Scope of Professional Practice (adapted from UKCC 1992)

1: The practitioner must be satisfied that each aspect of practice is directed to meeting the needs of the client
2: The practitioner must maintain and develop knowledge and skills to meet those needs
3: The practitioner must acknowledge any personal limitations of knowledge and skill to respond to these needs.
4: The practitioner must ensure that any enlargement or adjustment of the scope of personal professional practice must be achieved without compromising or fragmenting existing aspects of care
5: The practitioner must recognise personal accountability for all aspects of practice
6: The practitioner must avoid inappropriate delegation in serving the needs of clients.

It has been suggested that nurses working within critical care areas often have very cordial relationships with their medical colleagues (Parsons 1994), however exactly where critical care nurses and doctors co-exist on this continuum is uncertain. Critical care nurses have been cited as having great ambition and drive (Hudak 1994) and of being well motivated (Norrie 1995). Unfortunately, there is another side to working within the critical care environment. A number of authors have identified it as being a stressful and constrained environment, with a significant level of burnout amongst the nurses (Lloyd Jones 1994; Hudak 1994; Norrie 1995). However, because of their wide portfolio of expanded roles, it seems likely that critical care nurses will be amongst the most emancipated of nurses. Unfortunately, there is no good research to confirm this. Accounts such as that of Webster (2000) suggest that within critical care it is possible for nurses to work productively and collaboratively with their medical colleagues in developing new roles. Yet it could also be interpreted that because such an account is in itself newsworthy, this may not yet truly represent the norm (Chaboyer and Patterson 2001). As a personal perspective, the author of this project has spent a number of years working and teaching within critical care and can confirm that at least in some units the nurses are a powerful group and do often work collaboratively with the medical staff, although as Ford and Walsh (1994) have suggested, this has often been on the terms of, and to the major benefit of the medical staff.

In terms of this project, a number of gender related issues have been addressed, but it is true to say that this section has raised questions rather than answering them. At the heart of the discussion is the way in which the predominantly female nursing staff work with the predominantly male senior medical staff. What has been suggested is that gender issues are relevant here and may significantly hinder true collaborative working between the two groups. Historically this has certainly been the case, but it could be argued that within critical care as roles expand, the balance of influence will shift towards the nurses. It is possible that the use of a CIS can further support this process, as it has been suggested that they make the sharing of information more effective (Lenz and Metnitz 1995). However, both Barley (1986) and Currie and Brown (1997) have shown that the introduction of technology

results in the changing of working relationships, but the nature of the change is not determined by the technology itself, rather by the results of negotiation between the involved parties. Although there is evidence that the critical care nurses are in a relatively strong position to develop their own practice, there is no reliable evidence that as yet they have emerged as being in an equal partnership with the medical staff, or really that they are near approaching such a position. This suggests that with the implementation of CIS, any new changes in practice are very likely to be primarily of benefit to the medical profession. Sadly there is no firm reason to believe that they will necessarily benefit the nursing profession, either by helping the individual practitioners deliver more effective care, or by supporting the goals of the developing profession at large. This would represent a real missed opportunity for nurses. It would also ensure a hazardous and problematical period of change for the organisation which implements the CIS.

The research agenda remains wide open. Little has been proven within this field. Criticism has become evident of the research methods used to elicit the relationships between nurses and the information systems they use. Therefore if a meaningful exploration of the relationship between nurses within critical care and CIS is to be undertaken, the point of departure must be a close examination of the methods available to the researcher and judicious choice of these is an important, if not critical step in the research project. Without this process more inappropriate research findings will only serve to cloud, rather than clarify the issues.

Methodology

Melia (1997) makes the distinction between *methodology,* the study and design of method and *method,* the research procedures actually applied. This chapter will deal with methodology. The research investigations which form the central body of the project fall into three distinct phases. Within each phase, the methods used will be discussed in discrete sections in chronological order. To understand their development however, it is necessary to follow the evolution of the research project, which has been an eventful and occasionally tortuous process. To allow this, two issues need to be examined before a thorough justification and analysis of the research tools used can be undertaken. These are, firstly the research framework envisaged for the project and secondly the narrative thread of the research project, and how it was maintained against changing events within the clinical environment.

In the absence of a consideration of methodology, a reliable and valid method would be purely serendipitous. It is generally held to be the case that nursing research belongs within the larger tradition of social science research (Bowling 1997; Thompson 1998) therefore it was a logical first step to examine the main theoretical frameworks within this field, and by critically examining them, evaluate ways in which they could contribute to the value of the research project.

Two 'schools' of social science have been described which have been associated with two different versions of research, positivism and interpretive social science, often shortened to 'interpretivism' (Silverman 1993; Clough and Nutbrown 2002). In positivism, the natural science method is used to explore the social world (Denscombe 1998). It is based upon empiricism, where data are collected by direct observation. It is associated by Silverman (1993), Bowling (1997) and Sarantakos (1997) solely with quantitative methods. The scientific method makes a number of assumptions. These include the assumption that social nature is lawful and can be understood as a sequence of cause and effect. In addition it assumes that behaviour is determined. This means that behaviour is solely influenced by natural causes and does not depend on choice or free will. The third assumption is that behaviour is understandable, that is no matter how

complex an issue appears, it can be logically and rationally analysed (Heiman 2002). It is strongly associated with testing of hypotheses and hence is largely deductive (Bowling 1997; Heiman 2002).

This poses two problems for this research project. Firstly, the literature review has identified that there is very limited good quality research which illuminates what nurses want from a CIS. This makes the formulation of hypotheses difficult. Furthermore, the initial research question (page 10) is essentially inductive rather than deductive in nature. Secondly, the classical (although admittedly, not the only) expression of positivism is experimental research. In an experiment, the hypothesis is tested by actively manipulating one variable (the independent variable) and measures changes in behaviour by measuring another variable (the dependant variable) (Heiman 2002). In order to do this it is necessary to control extraneous variables, so that it is only the effect of the independent variable that can be discerned. This can be extremely difficult to do and can limit the quality of the research (Jadad 1998). Within critical care environments, change is constant. Nursing staff may change on a weekly basis. The nature of the patients, their conditions and acuity will change, often on an hourly basis. Skill mix will change as will therapies. The list could go on, indeed almost any category of activity which can be defined within a critical care unit will change. Without extensive resources, control over extraneous variables will not be possible. However it is true to say that such a design represents an extreme viewpoint. Not all positivist research necessarily uses experiments. Other examples include correlational and *ex post facto* designs (Black 1999). However this discussion does highlight that the positivist paradigm would be difficult to use for guidance for this particular research project

As a possible alternative, the interpretivist paradigm needs to be explored for its suitability. Silverman (1993) describes the interpretive perspective as providing observation and description of the social world including the contexts in which people live. In support of this, May (1997) suggests that it deals largely with subjective experience and so is very different from the objective reality postulated by positivism. Similarly Denzin and Lincoln (2000) describe it as encouraging

naturalistic exploration (i.e. investigating the natural world) and multiple perspectives on the subject being studied. Thus the context of the investigative environment is maintained. Both these authors associate this paradigm with qualitative investigation and suggest that it is largely inductive in nature (Bowling 1997). Therefore cause and effect are not explored, instead hypotheses and theory are produced. However, these are not rigid rules. For example, Silverman (1993) cautions against unnecessary polarisation between qualitative and quantitative methods. Indeed both Polit et al (2001) and Duchon and Kaplan (1988), who operate from an interpretivist viewpoint, also identify valuable roles for quantitative research.

This project will be guided by the interpretivist paradigm. Control over variables is unlikely to be feasible. This would be a weakness working within a positivist paradigm, but becomes a strength in an interpretivist one, allowing the maintenance of the context within which the nurses work. This will support applicability of the findings back into the clinical area, which accords well with the pragmatic nature of the project. Secondly, the initial stages of the project will of necessity be inductive, because so little is known about what the nurses want from a CIS, that it would be impossible to formulate good working hypotheses before fieldwork is undertaken and analysed. However as a final note, Silverman (1993) cautions against rigidly adhering to any paradigm and encourages flexibility. Thus whilst operating from an interpretivist framework will give guidance to the project, possible contributions from quantitative methods will not be ignored and even methods which have attributes of experimental study may be considered. The important criterion is whether or not they add to the quality of the research project.

Terminology

Research methodology can be confusing. Classification of the different types of methodology is complex, with different sources using different taxonomic groups (Crabtree and Millar 1992; Miles and Huberman 1994). This discussion intends to aim primarily for clarity and illumination. Therefore although a number of theoretical concepts will be discussed, they are included only in order to critically

analyse how they can contribute to the quality of the research. This therefore is not a theoretical discussion, but an applied one. It will also be eclectic. It is intended that this will avoid what has been described as inflexible adherence to the separate methodological traditions, which could result in restrictive prescriptions for research practice (Atkinson 1995).

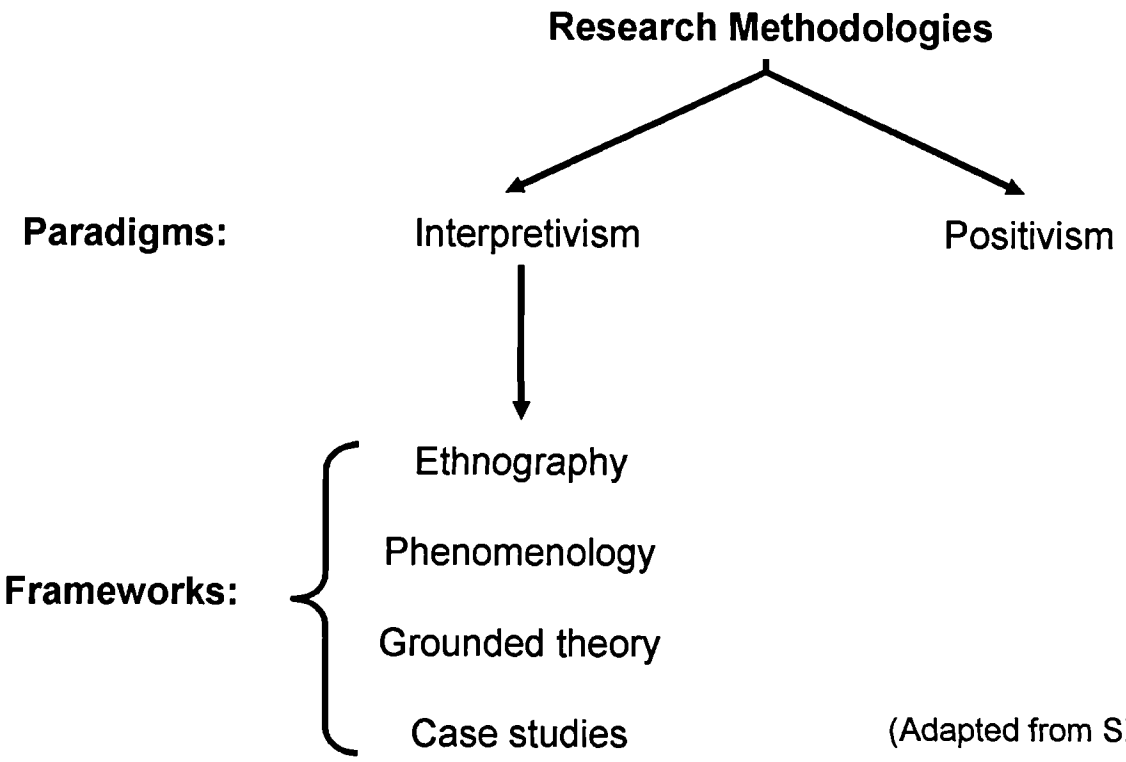
Just as the actualities of research methodology can be complex, so can the terminology which reflects its development. To maintain clarity, the following terminology will be used, adapted from Silverman (1993), because it is both clear and flexible. The interpretivist perspective will be described as the central *paradigm* for this work, within which a number of research *frameworks* exist (diagram one). A number of frameworks have been reported in the literature, the next step is to consider which contain qualities that can support the research.

The contributions from research frameworks

The popularity of research frameworks appears to be influenced by fashion as well as by appropriateness (Bryar 1999). Cresswell (1994) identified at least 20 frameworks which have been reported in the literature, derived from a number of historical backgrounds such as anthropology, psychology, sociology and biology. Clearly it would be a wearisome task to discuss each of these. In summarising his review, Cresswell (1994) identified four frameworks which were widely reported in human and social science research: ethnography, grounded theory, phenomenology and case studies. The object of the next four sections is to examine how, or if, each of these can contribute to the research project.

These frameworks are almost wholly associated with qualitative methods, although once again it could be argued that this is a false, or at least unnecessary, polarisation (Silverman 1993; May 1997; Bowling 1997). Because of this, they will be discussed as though they apply to qualitative methods only, but the case for a contribution from quantitative methods to the research project will be examined subsequently.

Diagram 1 Summary of the research taxonomy used



(Adapted from Silverman 1993)

The contribution of ethnography

Ethnography was initially developed by anthropologists. It involved immersion in a culture over an extended period, based upon learning the language and participating in social events with the people of that culture (Silverman 2000). It proposes that the social world should be studied in its natural state, undisturbed by the researcher. This viewpoint has been termed 'naturalism' by ethnographers. A key element of naturalism is that the researcher adopt an aspect of respect or appreciation towards the social setting, and becomes immersed within it. This is in direct contrast to the positivists' necessity to control the environment in order to test hypotheses (Hammersley and Atkinson 1995).

According to Denscombe (1998) there are five key characteristics that distinguish ethnography from other branches of interpretivist research and this structure will be used to ascertain whether the research project is amenable to an ethnographic methodology. Firstly, in ethnography, the researcher spends considerable time in the field among the people whose lives and culture are being studied. The ethnographer needs to share in the lives rather than observe from a position of detachment. Is this achievable within the research project?

The critical care environment is unique. Heavy physical and psychological demands are placed upon the nurses who work there. It is a stressful environment (Hay and Oaken 1972; Dear & Weisman 1982; Norrie 1995). To make sense of the phenomena encountered within the clinical setting, an extensive knowledge of it is required and an outsider would have difficulty in interpreting events. However, due to resource constraints it is not realistically possible for the researcher to spend large amounts of time immersed within this setting. Fortunately the researcher already has knowledge of the clinical setting, having been employed in a number of critical care units as both staff and charge nurse. As a lecturer he has taught students from the specialty and throughout the duration of the project has worked periodically within critical care on honorary contracts. Some aspects of immersion therefore have been achieved and it could be argued that the researcher, although not immersed on a daily basis within the environment, does however have a perception of the ethos of these units and the

ways in which the nurses work. This could be important in structuring the research tools and in the interpretation of the research findings.

Secondly, Denscombe (1998) stated that in ethnography, the ordinary aspects of every day life are regarded as worthy of consideration as research data: the mundane and ordinary are just as valid as the special events and ceremonies which can capture attention. This illustrates an integral goal of this research project. It is the daily and unremarkable interactions of the nurses which are the central issues for this research. Although critical incidents will undoubtedly have an impact on the ways in which the nurses view a CIS, it could be suggested that it is more likely that it is the daily routine interactions which will influence the staff.

Thirdly, Denscombe (1998) suggested that in ethnography there is special attention given to the way people being studied see their world. Again this is a viewpoint which is really at the heart of this project. Of the research which was reviewed during the literature search, consistently there was minimal appreciation of the nurses' values. Perceptions were imposed upon them as to what was significant or rewarding for them as a group (for examples see Crewe et al 1987; Lutheran Hospital 1991). Although in a methodology section it would be unwise to make unrealistic claims, one original feature of this research will be that of listening to the voices of the nurses (at times literally) as they describe their daily work. There will be no attempt to impose upon them another group's judgements as to their workload, or the issues which non nurses feel are important within the clinical area. It will enable the nurses' voices to be heard.

Denscombe's (1998) fourth criterion was that in ethnography special attention is given to the way people being studied see their world. As a concept, this is less easy to map on to the design of the research project. Ethnography originated from anthropology, looking at indigenous peoples within their own cultures (for example see Mead 1928). Within this is the concept of allowing the subjects to live their normal lives and maintain their associations. The similarities between the lives of tribal peoples and nurses within a closed clinical environment are striking, with complex hierarchies and rituals and customs (Mead 1928; Walsh and Ford 1989). It is not within the remit of this work to explore this in detail, but it

does stress that nurses work within a complex team within a bounded environment. Therefore to take what they do or say outside of these limits would be to isolate and weaken the research findings.

Denscombe's (1998) final criterion was that there should be some acknowledgement that the ethnographer's final account is more than a description, it is a construction and inevitably owes something to the ethnographer's own experiences. This phenomenon has been termed reflexivity. Hammersley and Atkinson (1995) argue that no researcher is free from the constraints of their social world and that therefore to claim to isolate a body of data uncontaminated by the researcher is specious. This position is not unique to ethnography, but it could be argued that it is particularly pertinent to the framework, since ethnography aims for immersion within the culture being studied. Therefore structure and interpretation of research have inherent biases. Conventional ethnographers use the concept of reflexivity as a given fact and use it to develop patterns or questions which can be further tested or explored (Hammersley 1998).

What do these ideas mean for this research project? There is an apparent tension, but also an apparent resolution of the tension. Firstly, although ethnography as a framework has great potential to add value to the research, this will not be an ethnographical design *per se*. The research was undertaken to answer specific research questions and therefore it would be unwise to aspire to an untainted label of ethnography. The tension is relaxed because the eclectic nature of the project specifically allows the freedom of choosing desirable elements from different frameworks, as long as it allows movement towards answering the research questions. This is essentially an acknowledged inclusion of reflexivity. However, there are also strengths in this approach. As Schumann (1982 p24) suggests, '*what is an artefact if treated naïvely, reflects a fact of life if treated seriously.*' This implies that observations made from the research data can be accorded significance by the means of analysis. This places upon the researcher (and hence the analyst) the burden of being aware of their own agenda and by identifying this, ensuring that it does not obscure the covert

agendas of the respondents. In simpler terms this complies with one of the stated terms of this project 'to let the nurses be heard.' As has been shown, to allow this is not a simple process, and although recognition of the problem is a positive step, it is not in itself proof of solving it. Therefore in addition to incorporating a number of elements from ethnography, this section will look further at the remaining frameworks, to identify how their precepts can support the research project.

The contribution of grounded theory

Glaser and Strauss (1967) argued for grounding theory within social research by its direct generation from data. Thus the main thrust of their work was inductive, although they also felt that the verification of theory was important. Using this approach means that hypotheses and concepts not only come from the data, but are systematically worked out in relation to the data during the course of the collection. Thus the relationship between theory and data is intimate and continuous. This intimacy is termed theoretical sampling and means that to a significant extent, data collection is controlled by the emerging theory and *vice versa* (Glaser and Strauss 1967). Therefore the initial decisions about early data collection can only be broad and general, allowing the research agenda and the theory to emerge as the process unfolds. As the early data are received, they are reviewed, with an initial analysis to develop categories which illuminate the data. Next an attempt is made to saturate these categories with appropriate cases in order to demonstrate their relevance. The process of saturation describes the compilation of data until a conceptual category becomes credible (Melia 1997). Lastly these categories are developed into more general analytical frameworks with relevance to their setting (Silverman 2000). A more procedural and simplified way of comparative analysis was subsequently developed by Strauss and Corbin (1990), through the process of open and axial coding of data to generate theory.

Silverman (2000) suggests that a weakness in grounded theory is that theories are generated, but that their verification is less rigorous, yet Glaser and Strauss (1967) state that verification of data as it emerges is an integral part of the

generation of theory, therefore the split between the two concepts is probably false.

Unfortunately grounded theory has been used by researchers who might lack a clear idea of the research goals, without a clear sample in mind, and with a general 'jump in at the deep end' approach. There is a real danger that the approach can be cited as a justification for sloppy research (Denscombe 1998). This debate has not been clarified by the fact that Glaser and Strauss themselves subsequently developed different interpretations of the concept and, as academics occasionally do, fell out quite acrimoniously (Glaser 1992). What are the strengths of this approach, and how can it inform the methodology of this research project?

Bowling (1997) suggests that qualitative research which adopts a grounded theory basis maintains the richness and spontaneity of the research environment. This is supported by Strauss and Corbin (1990) who argue that a number of different methods are applicable within the construct of grounded theory, and that it is a generalist framework which can be applied to different research environments. This is exciting within the framework of this project. What it presents is a framework which is strong enough to support data collection, analysis and theory generation with considerable rigour, but is also flexible enough to allow changes within the research environment, so that as data are collected and explored, the next step of the research can be identified and defined within a changing clinical environment.

What else can grounded theory offer? An issue which has been identified earlier was the imposition from other groups of workers of definitions of nursing, which rendered subsequent analyses suspect. This is one aspect in which grounded theory can make a significant contribution, because the *nurses themselves* will generate the data from which the theory is derived. If nothing else of value is achieved by this project, this will still represent a novel contribution to the available literature.

Finally, it is worth noting that grounded theory and ethnography are not mutually exclusive. Indeed, grounded theory is an important tool that can be used

by ethnographers (Hammersley and Atkinson 1995). One area of theory where both frameworks come together and overlap is that of 'theoretical sensitivity' (Glaser 1978). This is a personal quality of the researcher which allows the identification of what is important within data and then the ability to give it meaning. Strauss and Corbin (1990) suggest that there are two sources for it. Firstly it comes from being well versed in the available literature as well as from personal and professional experience. It is believed that the author of this work fulfils these criteria. Secondly, it is also acquired during the research process through interaction with the data. In other words data analysis is not a once only event, but is instead a cyclical one, leading to imaginative theory. However, Strauss and Corbin (1990) advise caution. Just because theory generated is imaginative and appears fresh does not mean that it is real. They advise that researchers should do three things to keep their feet on the ground. Firstly it is wise to maintain an attitude of scepticism towards any theories generated early in the research and secondly to validate these repeatedly throughout the project. Lastly the researcher should use robust and transparent data collection and analysis procedures.

There is one final condition. At the outset of this discussion it was stated that the research methodology would be pragmatic in nature. Strauss and Corbin (1990) suggest that the researcher should be prepared to regularly stand back from the data and ask 'what is really going on here?' This appears to be excellent advice, so that even when using a framework to explore research findings, there is still the ability to step outside the theoretical design and gain fresh perspective. It is hoped that by using both theoretical and pragmatic perspectives good theoretical sensitivity will be achieved which will result in rigorous and meaningful findings.

The contribution of phenomenology

Thus far, ethnography and grounded theory have been explored. Both have been useful in exploring issues which help define the structure of the research project. What can phenomenology contribute?

Phenomenology aims to grasp the essential meaning of a phenomenon. As a process it is both simple and difficult. It is simple because it is something that everyone does in everyday life. It is difficult because the ways in which this reflective determination can be formalised is complex and elusive (van Manen 1990). Phenomenology is based on the paradigm that reality is socially constructed through the actions of individuals who interpret each other (Bowling 1997). One major difference between phenomenology and the other frameworks is that phenomenology is non interpretive. Interpretation is the process of clarifying meaning, for example by data coding and analysis. Phenomenology by contrast is concerned with the bestowal of meaning onto data (Georgi 1992). This has been described as the 'day to day experience' (Rather 1992) or the 'lived experience', with the inference that this experience is to be understood from the individuals' perspective (Crotty 1996). By undertaking this process it is the task of the researcher to gain entry into the conceptual world of the informants, allowing them to construct and give meaning to their own reality (Montbriand and Laing 1991).

This suggests that phenomenology has the ability to invoke powerful perspectives in the presentation of data. How can this be achieved with rigour? Crotty (1996) identifies that in many ways phenomenology is a disputatious field of study with many authors using terms in different ways.

Firstly, what is meant by the study of phenomena? It lays stress upon the subjectivity of experience. For example, person A may view a painting and call it ugly, person B may view the same painting and call it beautiful. For person A the painting will have all of the phenomenal properties of ugliness and for person B it will have all the phenomenal properties of beauty. However, no claim is made that the painting is in itself either ugly or beautiful, only its presence for the experiencer counts (Georgi 1992). Crotty (1996) in a review of phenomenological researchers concludes that for better or worse in practice this means overwhelmingly a study of subjective experience. Crotty (1996 p.19) concludes that *'given this task, the first enemy to be confronted is the researcher's own standpoint.'* This can be achieved (according to phenomenologists) by bracketing.

This means that the researcher has to put aside any intellectual baggage they have in order to allow the subjective views to flow. Our preconceptions and presuppositions need to be bracketed, in order to present a clear focus on the subjective experience, to allow informants to construct and give meaning to their reality and to provide untainted data (Lethbridge 1991; Crotty 1996). Is this achievable? According to Montbriand and Laing (1991) this is doubtful and they suggest that to some extent the findings will always be dependant on the researcher's interpretation. However Crotty (1996) concludes that bracketing can be an honest process which allows the data to emerge in their own form and speak for themselves. On one level this is consistent with the research project, which is an honest endeavor to put aside preconceptions about the nurses and their interactions with the CIS. However, on another and possibly more significant level, at this point the research agenda veers away from phenomenology. The research project has been designed to answer some specific research questions. Although it is greatly desired that any data will be pure and untainted, because of this objective focus it does not allow a phenomenological approach. The 'baggage' is present in the questions, and the questions are central. However, the concept of bracketing remains important and may be able to contribute significantly to the data analysis and data collection.

Therefore it would be disingenuous to purport this research project as 'phenomenological', yet, there are valuable qualities associated with the phenomenological viewpoint. The topic undertaken and particularly its nurse centered focus is unique, and it is uncertain what will emerge. By being aware of the enormity of the value of the subjective data from respondents, it is possible that important unreported and novel realisations may occur, which could otherwise easily be missed.

The contribution of a case study framework.

Gillham (2000a p.1) defines a case as *'a unit of human activity embedded in the real world which can only be studied or understood in context.'* This is clarified by Yin (1994) who states that a case study investigates a contemporary phenomenon within its real life setting which copes with a technically distinctive

situation. The research is therefore highly contextualised and there is the assumption that the environment is important to the topic being studied. Therefore for a successful case study strategy, the boundaries of the case must be identified and the investigations must be situated within these boundaries. Platt (1992) further identifies that a case study approach entails the collection of intensive data about all aspects of the case, and shows that it aims to treat the case holistically rather than isolating variables. Is the proposed investigation of the impact of a CIS appropriate to this strategy?

There is certainly evidence that it may be so. For example the critical care unit represents a discrete environment. Its boundaries can be delineated clearly. Geographically it is distinct. It is also unique in terms of the nurses and other disciplines who work there and the types of activity which they undertake.

Yin (1994) describes case studies as a strategy for research rather than a tradition, or paradigm or other arcane term. This infers that the use of a case study is a strategic decision that relates to the subject under study, but does not dictate which method or methods should be used (Denscombe 1998). This is not unique. Both ethnography and grounded theory also allow encourage flexibility, but with case study designs, this flexibility constitutes an acknowledged strength of the approach. Similarly a further component of Yin's (1994) definition of a case study includes its use of multiple sources of evidence, with data needing to converge through a process of triangulation. This is in agreement with Bryar (1999) who reviewed a number of case study research projects, and found that the majority used both qualitative and quantitative investigations, within a bounded unit.

Thus the use of a case study may enhance the project. It will however also impose imitations. What distinguishes a case study from the other frameworks is the ability to focus the investigations to answer specific questions relevant to the case (Gillham 2000a). This freedom is a very attractive proposition. It allows the design of an in depth investigation of a particular case where the research methods are chosen for their suitability to investigate the phenomena within the particular environment. As Sackett and Wenberg (1997 p1636) put it:

'our thesis is short: the question being asked determines the appropriate research architecture strategy and tactics to be used: not tradition, authority, experts, paradigms or schools of thought.'

There are however a number of issues concerning the use of case studies. Reliability and validity are issues within research which must be considered but are seldom completely resolved. The case study certainly does not possess an automatic exemption from these issues. However, Yin (1994) puts forward a spirited defense of the strategy. He suggests that if the researcher is diligent in the structure of the case study, these issues can be meaningfully addressed. In order to support validity. A number of strategies can be adopted. These include the use of multiple sources of information, the establishment of a chain of evidence and review of draft reports by key informants. All of these activities will be incorporated. Reliability is a slightly more complex issue. Reliability suggests that if a later investigator were to repeat the study, the same findings and conclusions would be arrived at (Polit et al 2001). There is a problem here, in that by definition the case itself is unique. For example, in a critical care unit, staff change rapidly, they may leave or be promoted or take on new duties. Attitudes towards computing may change with time. Physically the unit may change, more beds may be opened to new medical or surgical specialities. Therefore, the case cannot be repeated. Yin (1994) states that this is not a completely resolvable issue. He suggests that it means making as many steps as possible with observable guidelines which should be independently scrutinised. Both Yin (1994) and Koch (1994) suggest that an audit trail should be apparent, each step should be derived from previous ones, the process should be open and the auditor should be able to follow the steps and findings from inspection of the study, so that the case is identifiable and the findings can be verified from within the context of the case.

The case study has one special attribute. The meticulous description of a case can have an impact greater than almost any other form of research report (Gillham 2000a). This represents a challenge to the writing of the researcher. Not only must the research be well planned, executed and written up, but it should

also be pithy and terse so that the strength of the nurses' feelings and utterances are presented vividly on the page.

The contribution of quantitative methods

Within the literature review it has been hard not to become dissatisfied about previous work addressing the nurses' interactions with, and attitudes towards, a CIS. Why then has there been not only a preponderance, but indeed a monopolisation of quantitative research methodologies?

A number of reasons are possible. Firstly, these methods are rooted in science and positivist viewpoints. They are commonly seen as delivering 'hard' data. Quantitative research is primarily concerned with numbers, which allows numerical and statistical analysis of the data which can be useful to provide measurements of the reliability of the phenomena which have been studied (Denscombe 1998; Cooper 1998). Secondly, much of the research has been undertaken by medical staff or nurses working with medical staff. The randomised controlled trial, generating hard data, remains the gold standard for the discipline of medicine (Jadad 1998) and it is possible that this is reflected in a readiness to apply quantitative methods to problems which might be more amenable to other methodologies.

There is a similar debate within nursing research, as to how appropriate quantitative tools are to investigate a humanistic profession such as nursing (Bowling 1998; Polit et al 2001). It is difficult for quantitative work to address issues such as the quality of human experience. However it can be argued that quantitative methods have some real strengths, which can add to the project. They can be rigorous, systematic and objective (Carter 1996; Getliffe 1998). Although generally agreeing with these points, Denscombe (1998) also identified the obverse, that quantitative methods could focus on specific points rather than holistic descriptions and that analysis could be rigid rather than reflecting emergent research data. In an article analysing previous quantitative analyses of CIS implementations, Norrie (2000 p74) found that much of the discussion from quantitative data examining CIS was *'seductive but glib'*, giving false certainties. To resolve this, it is envisaged that the project will use both qualitative and

quantitative methods. The initial phases will use qualitative methods which will provide the depth of data to explore the agendas of the respondents. This will be an inductive process concerned with the generation of theory (May 1997). The quantitative phase will then exploit this rich material by delivering it to a wider audience, allowing expression of the strengths of this branch of methodology. This final phase will therefore be deductive, applying the data back to practice (May 1997). It is intended that a synergistic mix of methods will result. There are precedents to this proposal. For example a similar technique has been used and been found to have value whilst exploring the impact of information systems in a pathology laboratory, and it has been suggested that this approach provides both richness and discipline (Kaplan & Duchon 1988; Myers and Haase 1989).

In summary, quantitative methodology will be employed to measure the quantity or extent of the phenomena identified, but this will be grounded in the central core of the work, the qualitative reports of the workers, allowing their voices to be heard.

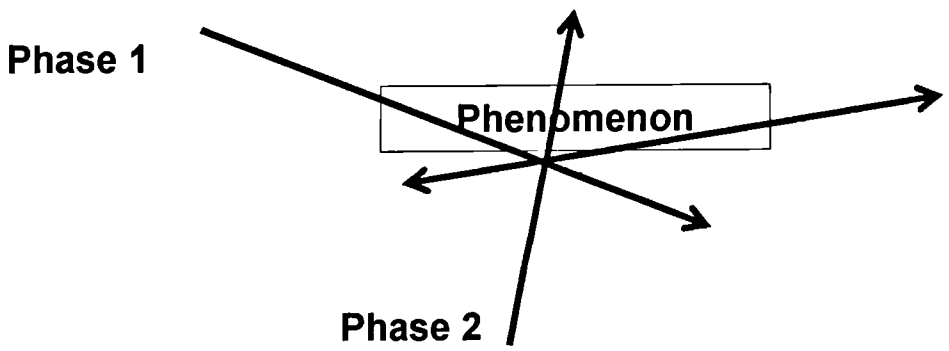
Triangulation

There is one final element to be discussed before using this review of methodology to construct a coherent framework to inform the research project. Triangulation is a research strategy that aims to enhance the process of research by using multiple approaches (Sim and Sharp 1998). It does not exclusively belong to any framework of research design, although traditionally it has been more aligned with some, particularly case studies, than others.

Triangulation is a technical term used in surveying and navigation to describe a technique whereby two known points are used to plot the location of a third. It was first used in the social sciences as a metaphor to characterise the use of multiple methods to measure a single construct (Shih 1998; see also diagram two). It has been defined more precisely as the use of multiple observers, methods and interpretive points of view in the construction of interpretations (Denzin 1989).

Denzin and Lincoln (1994) identify a number of types, of which methodological triangulation is the most relevant to this project, although theory triangulation will

Diagram 2 Methodological triangulation



Adapted from Denscombe 1998

also be considered. Methodological triangulation is the use of more than one method of data collection in the study of a social phenomenon. It can be divided into two subtypes. *Within method* triangulation refers to the use of more than one technique of data collection within a particular methodological approach. For example both a Likert scale and set of questions might be included within a questionnaire. By contrast, *between method* triangulation involves the use of two or more distinct methodological approaches to data collection, for example a set of open ended interviews, in addition to an observational study (Denzin 1989). In each case it is intended that the shortcomings of one technique or method will be compensated for by the strengths of another (Yin 1994; Denscombe 1998; Sim and Sharp 1998). The use of both quantitative and qualitative methods has already been proposed, *therefore triangulation, primarily of the 'between method'* type, will be used, although the 'within method' type will also have a role to play.

Lastly, in theory triangulation a range of theoretical models is used in the same study (Nolan and Behi 1995). Propositions derived from competing theories or frameworks are applied to the same data set. This process produces an assessment of the power and utility of competing theories, hypotheses and alternative explanations (Denzin 1989), and as such it is quite a specialised tool. There may also be a role for theory triangulation, which will be illustrated in the next section.

A number of authors argue that triangulation of whichever type can add to the quality of a research project (Denzin 1989; Yin 1994; Nolan and Behi 1995; Maggs-Rapport 2000). Yin (1994) also suggests that this helps address validity because the multiple sources of evidence provide multiple measures of the same phenomenon. This has been supported by a number of nurse researchers including Carr (1994) and Bradley (1995). Nolan and Behi (1995) even go so far as to call triangulation the research trend of the 1990s! Such enthusiasm merits caution. As identified earlier, research is not immune from the whims of fashion (Bryar 1999). In addition, both Yin (1994) and Denzin (1989) point out that triangulation can be more expensive than if data were derived from one

investigation. This seems inescapable and may be unnecessary if the chosen research method adequately corresponds to the research question.

There are other issues concerning the use of triangulation. Sim and Sharp (1998) suggest that in order to support validity, one phase within the investigation in the triangulation repertoire needs to be given prominence i.e. it is the 'gold standard' and the others are used to justify its worth. This means deciding in advance that one method is intrinsically more valid than another. This is in contradiction to the basic premise of triangulation, and this represents a theoretical impasse. However, a possible solution to this will be outlined in the next section.

Sim and Sharp (1998) also identify a further problem when attempting to combine methods. At the centre of the problem lies the fact that methods of data collection do not exist in isolation as neutral tools to be selected solely on the basis of the problem to be examined. Instead they usually contain some implicit fundamental assumptions about the nature of the investigation. For example we seldom interview botanical specimens. It may be possible therefore for the different strands of the investigation to result in a number of discrete data sets, which essentially are unable to 'talk' or correspond with each other, which will negate the ability to triangulate findings.

One final issue is raised by Denscombe (1998). He argues that the analogy with navigational triangulation should not be pursued too vigorously because it assumes that there is a fixed point which can be measured. This comes perilously close to a positivist viewpoint, suggesting that there is an objective reality, whereas much of social science (and indeed this project) argues for a more subjective view of reality (Polit et al 2001). To a certain extent this problem is resolved by Patton (2001) who argues that a common misunderstanding about triangulation is that the goal is to demonstrate that different data sources yield essentially the same result. However this is a simplification, what is at least as interesting are the *differences* yielded, which should not be viewed as weakening the results, but rather offering opportunities for deeper insight. Clearly, it would

seem unwise to suggest that triangulation is a panacea for weak research design, rather it is a tool which can be used well, or poorly.

Identifying the research framework

As has been shown, each of these methodological concepts has something to offer the project. Their contributions will be summarised in ascending order of influence.

Firstly, the project is definitely not based upon phenomenology. The research questions are too focussed and it could be argued that the topic itself is not very suitable. However, phenomenology is influential and gives us some ideals which can be sought for. Rather than tie the researcher down with prescribed procedural analysis of data, phenomenology allows (and perhaps promotes) powerful and vivid flashes of insight (van Manen 1990). It allows for multiple interpretations of the same phenomena and puts the emphasis not on proving a point but instead on appreciating the opinions and views of the subjects (Crotty 1996). These are very valuable perspectives and the project would be considerably enriched by their inclusion. In addition, the concept of bracketing is valuable, although whether it can be entirely achieved is a matter of debate, even amongst phenomenologists (Montbriand and Laing 1991). All of these ideas are important and will enhance one of the central tenets of the project, that the work must be nurse focussed, and must take into account the nurses' subjective experience.

Equally, the project is not an ethnographic one. However, critical analysis again yields some important concepts to guide the research. Ethnography deals with immersion, investigating daily interactions and being open to the informants (Denscombe 1998; Silverman 2000). The importance of being grounded within the research base is central if sense is to be made of the sometimes highly technical and context grounded responses made by the subjects. This is also true of the need to be aware of reflexivity (Hammersley and Atkinson 1995). All of these elements will support validity and all are at least potentially achievable.

Both phenomenology and ethnography therefore have important influences on the project, but neither really provides the procedural guidance required. This

leaves two frameworks: grounded theory and the use of a case study, both of which are at the heart of the research project.

Grounded theory is valuable because as a largely inductive framework it can be used to generate theory (Glaser and Strauss 1967) about the ways in which a CIS affects nurses, theory which has not been previously addressed. It also provides ways, through the process of comparative analysis, in which to achieve this (Strauss and Corbin 1990). It can allow flexibility in choosing research methods and provides rich data (Bowling 1997). It is intended to use grounded theory to provide the initial inductive aspect of the project. However to only generate theory is not a satisfying end in itself, for the pragmatic researcher. It is planned to then pursue the findings within a case study approach.

The use of a case study brings with it increased flexibility in choosing research tools, both quantitative and qualitative and the ability to explore focussed research questions (Yin 1994). Like grounded theory it is based within the context of the research setting. What is particularly attractive is the ability of the case study to provide the deductive answers to the inductive questions posed by the initial grounded theory component. Therefore it is suggested that a combination of both case study and grounded theory will serve as the main research framework for this project. However, it would be naïve to suggest that the two frameworks can be simply conjoined without tension appearing. In order to resolve this tension an adapted research framework is proposed, which will allow the project to both ask and answer focussed research questions.

The narrative thread

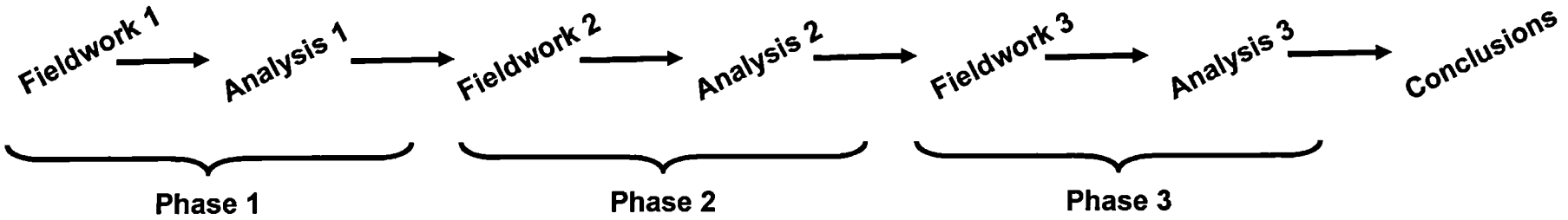
One of the readily apparent problems in combining a grounded theory approach to a case study is that of focus. Grounded theory uses general questions (Glaser and Strauss 1967) whereas a case study uses more highly focused questions (Yin 1994). How can the best be obtained from both perspectives? The issue that is raised is related to reflexivity. The agenda for the ways in which nurses utilise or are affected by a CIS has never been satisfactorily addressed (Norrie 2000a). Therefore it is impossible to produce *de novo* the valid tightly focussed questions

which a case study requires. It is proposed that this situation can be addressed by the development of the narrative thread.

Consider position one (diagram three). Phase one is the start of the narrative thread and represents an initial grounded theory investigation. Data are collected during the first set of fieldwork. During the analysis of phase one, the focused questions which are required for the case study aspects of the design are developed. These are used to deliver the agenda for phase two. Using a case study design by definition allows a large degree of flexibility in choice of research tool (Denscombe 1998; Yin 1994; Bryar 2000). Therefore the researcher is in the position to choose the most appropriate tool to carry out the fieldwork within phase two. This process then continues from data collection through further analysis to tool selection at phase three and so on (at least in theory) *ad infinitum*, forming the narrative thread. This scheme is certainly not revolutionary and could easily be described as one expression of a fairly standard research process. However it does allow a number of objectives to be considered. Firstly it allows both a grounded theory and a case study approach to be explicitly combined. Secondly it allows both induction and deduction to be included within one framework. Finally it allows the optimisation of research tools at each stage and it is highly flexible, giving the researcher the ability to change data collection methods at each stage of analysis.

There are of course limitations as it stands. Firstly in terms of the current research project, the case study element limits the exploration of the topic within time and place. Suppose for example that data from an earlier investigative phase suggested that a CIS, which had the ability to remind nurses of the time to administer drugs, provoked resistance. To explore this further it would be necessary to investigate a unit where such a system was in use. The narrative thread therefore argues for greater flexibility than conventional case studies, because the researcher cannot accurately predict the course of the research and what is needed within the research setting. Therefore the narrative thread should not necessarily be physically bounded at all. What would be required is that the

Diagram 3 **Position one: Relationship between intellectual challenges identified in the literature review, the narrative thread and the concluding analysis**



clinical setting should have the phenomena within it, exploration of which can help explore the research questions generated by the narrative thread.

Position one has two further limitations. Firstly the derivation of conclusions is postponed until the end of the narrative thread. This is disingenuous, as the researcher will in reality be working through data both inductively and deductively as the measures proceed, a feature of grounded theory (Glaser and Strauss 1967).

One possibility resolution of this issue is given in position two (diagram four). What is proposed is that at each stage of data analysis, intellectual challenges are identified and theory generated between phases, in line with the methods adopted by Hollway and Jefferson (2000). It is intended that this will allow a more natural delivery of conclusions from the data, which can then be used to further enhance the subsequent phases in the narrative thread. Position two also suggests that the final stage of the narrative thread would be a comparative analysis of the theory derived from the individual phases, termed the 'concluding analysis', hence theoretical triangulation will be included.

One further issue remains. Both position one and two (diagrams three and four) imply an extensive use of bracketing. As has already been discussed, bracketing is to some extent a doubtful process (Crotty 1996). One further criticism which could be put forward for bracketing is that it is wasteful. When embarking upon any research project, the researcher will, and indeed should, already have investigated the subject and be aware of previous workers and their findings (Silverman 2000; Bowling 1997). Whilst amassing this information, the researcher will also be identifying intellectual challenges which could potentially be used for theoretical analysis of data. It could be suggested that to then suspend examination and usage of this information is not an efficient use of the researcher's knowledge and skills. A potential resolution of this problem is given in position three (diagram five). The main repeating component is a unit derived directly from grounded theory. As Glaser (1978 p31) reported:

'In our approach we collect the data in the field first. Then start analysing it and generating theory. When the theory seems sufficiently grounded and

Diagram 4 **Position two: Relationship between intellectual challenges identified in the literature review, the narrative thread and the concluding analysis**

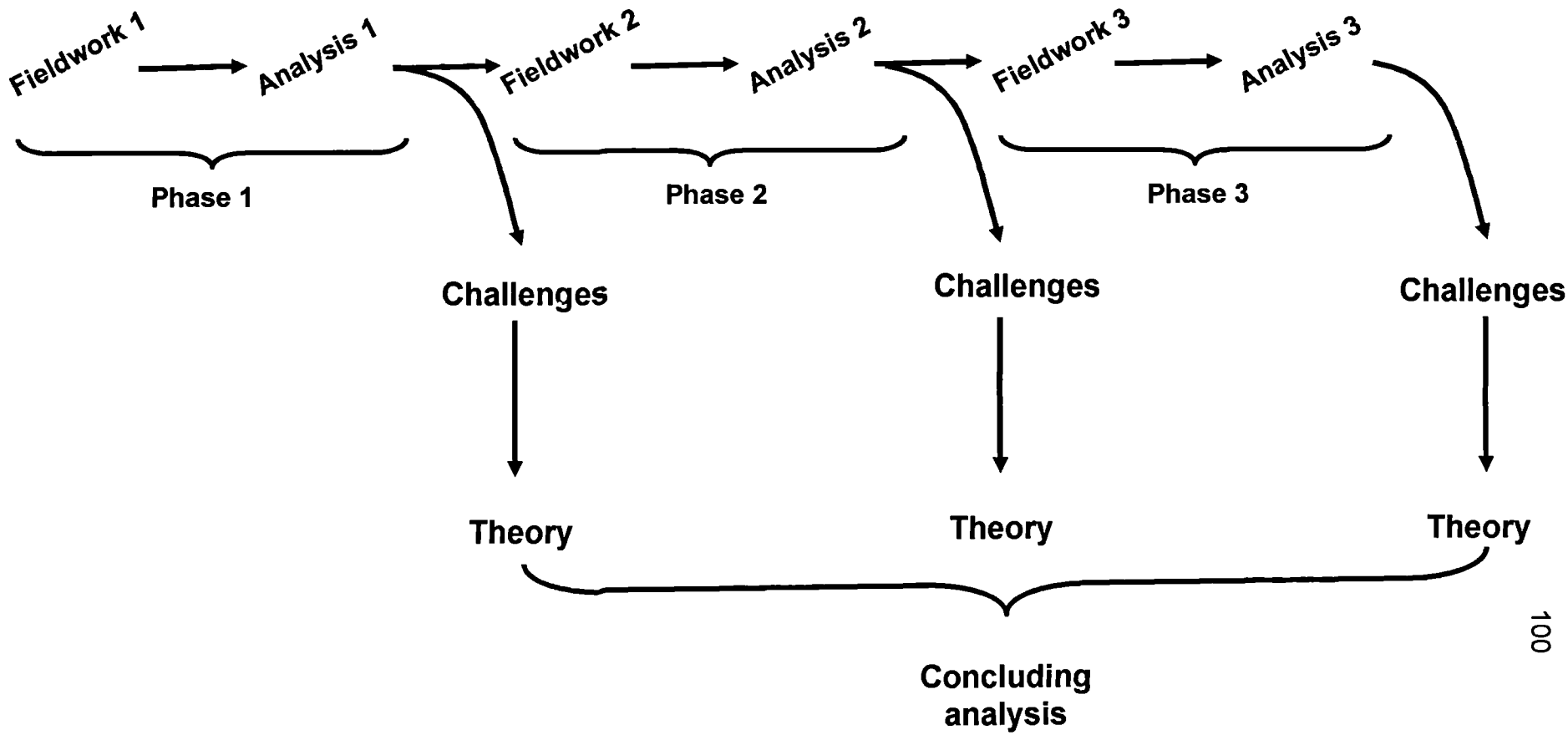
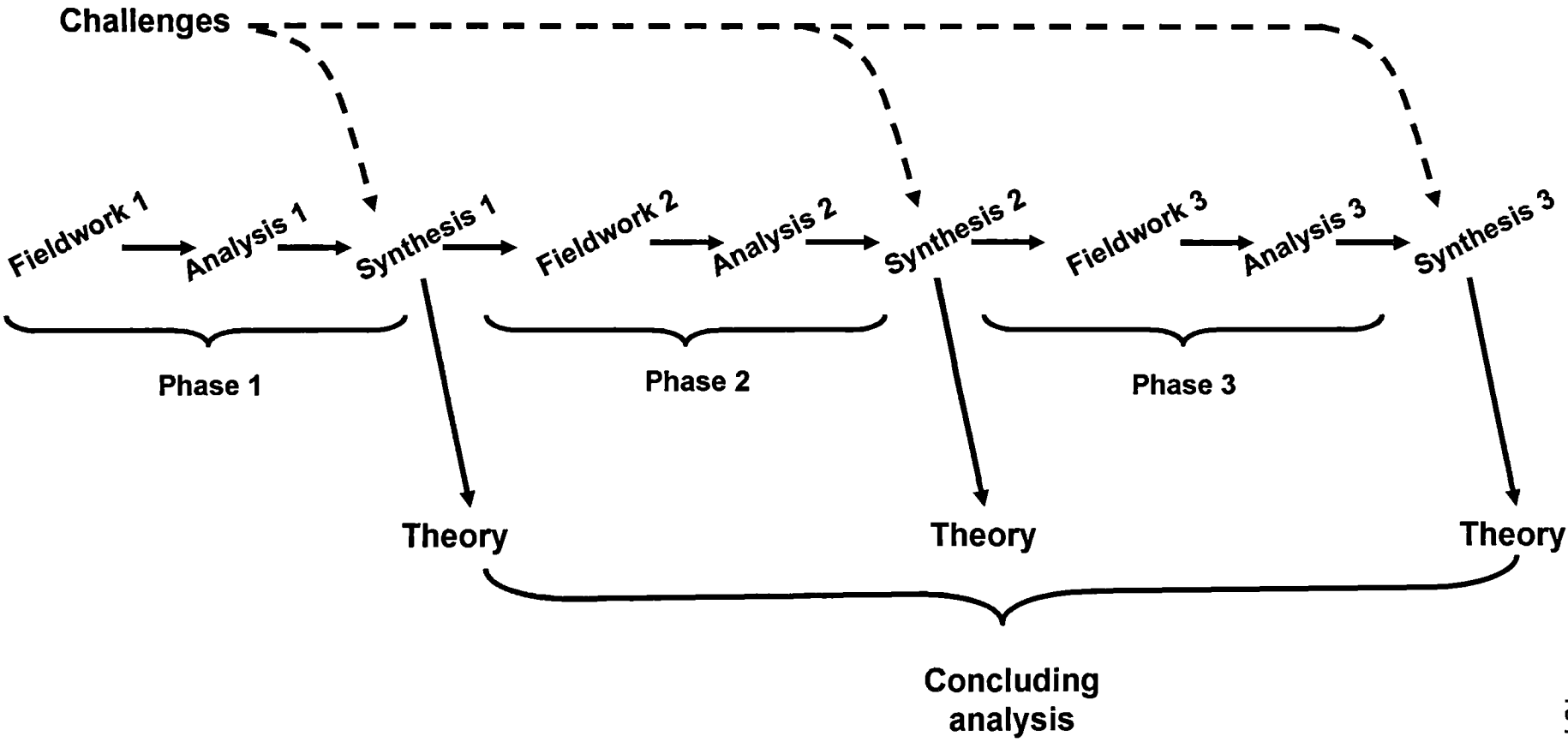


Diagram 5 **Position three: Relationship between intellectual challenges identified in the literature review, the narrative thread and the concluding analysis**



developed, then we review the literature in the field and relate the theory to it through the integration of ideas.'

The generation of theory

Examination of diagram five suggests that application of the narrative thread should result in the transparent generation of theory. A theory is defined as an 'explanation of a system', or as 'an exposition of the abstract principles of a science' (Chambers Concise Dictionary 1992). Polit et al (2001) similarly state that theory contains abstract generalisations which can present a consistent explanation about the relationships amongst the phenomena.

All these definitions suggest that theory generated from data can be applied to systems of phenomena and will have some element of predictability between systems. This is important for this research project, as it is intended that the research findings will be used to generate theory that can be applied to practice. Without this property, the contribution to knowledge is a dead end. This is supported by Denzin (1989) who suggests that theory leads to explanation and prediction of the phenomena in question. However, there is a problem here, in that although there is a consensus amongst social scientists that theory is important in the development of knowledge, there is actually a dearth of clear definitions of what theory actually is (Frankfort Nachmias and Nachmias 1996).

Bowling (1997) discusses three different types of theory, adapted from the work of Frankfort Nachmias and Nachmias (1996), which in itself is derived from a broader review of earlier social science theorists. This classification will be adopted for the project because not only does it possess clarity, but it illustrates the various inter-relationships between the elements of the theory and the phenomena which they relate to. In addition, Bowling (1997) is very clear in identifying both the strengths and the weaknesses of the different levels of theory.

At the lowest level, theory can be an *ad hoc* classification system, consisting of categories which organise and summarise empirical observations, similar to Polit et al's (2001) definition of a descriptive theory. This level of theory is not satisfactory for this project, because it is not sufficient to only describe. The work

should also explain the phenomena which it investigates. With relation to grounded theory data analysis, this is analogous to the generation and processing of open codes, where the relationship between phenomena is detected but not analysed. The next level of theory described by Bowling (1997) is that of a conceptual framework, similar to Polit et al's (2001) definition of a classical theory. At this level, categories are systematically placed within the structure of propositions. The propositions summarise and provide explanations for further observations. This stage is analogous to the production of axial codes, in that larger connections are made between different phenomena. However, although providing a more significant analysis of the data, this is still not ideal. The generation of theory is still rooted within the data and the ability to transfer the theory to other new phenomena or settings is unproven.

As an aim, it is intended that the data will be used to generate axiomatic theory, which is Bowling's (1997) third level. An axiom is a self evident truth or a universally received principle (Chambers Concise Dictionary 1992). Axiomatic theory contains a set of axioms and operational definitions, similar to Glaser and Strauss' (1967) claim that theory contains both properties and categories. Therefore new theory states not only the relationship between phenomena, but also the conditions under which the relationships hold true. This is the level of theory to which the research project aspires, as this will be theory that is both transferable and predictive and will thus be a true original contribution to knowledge (Phillips and Pugh 1994). Bowling (1997) however cautions that axiomatic theory is not easily attainable, because it is difficult to identify the criteria under which the axioms function accurately. It is hoped that the modified case study approach as well as the grounded theory basis for data analysis will contribute to this, as both will help define the context of the research, hence the context of the data and hence (it is intended), the context of the theory that is then generated.

Summary of the narrative thread

Within each phase of the narrative thread, there are therefore three elements: the fieldwork, its analysis and then a synthesis based upon the intellectual challenges

already identified by the researcher. At this point, the strategy for the subsequent phase in the narrative thread can be arrived at. Again, the generation of theory occurs at each stage, allowing a concluding analysis to take place so that, in addition to methodological triangulation, there will also be theory triangulation, however with two novel features.

One limitation of triangulation identified earlier was that in conventional triangulation one phase of research inevitably takes precedence over others (Sim and Sharp 1998). Because the narrative thread is sequential it is intended that comparison between phases will also be sequential, therefore there will be no hierarchy, instead each phase will be given equal weighting as its contribution is judged in turn. Secondly, Denscombe (1998) reported that triangulation, if used too rigidly, implied that the subject of the study is one objective phenomenon, which is unlikely and is contrary to the interpretivist perspective. The narrative thread acknowledges this by following the aspects or dimensions of the phenomenon as they unfold. In other words the triangulation will not attempt to define a single point, but instead will obtain different perspectives as it parallels the research focus (diagram 6).

What is hoped to be obtained from the narrative thread is the most efficient use of knowledge allied to a flexible research process, based upon grounded theory and an expanded case study format. As with any form of research framework it will be necessary to consider criticisms and limitations. What is intended is to use the narrative thread as a tool to give structure to the project, and to then critically appraise its usefulness in the concluding analysis. The critique will therefore be an applied rather than a theoretical one, and it is believed that this falls largely within the pragmatic ethos of the work. The first hurdle for the narrative thread was whether it could keep up with changing events within the clinical area.

A cautionary tale

The research project which was initially proposed was quite different from the one which eventually was undertaken. The twists and turns that resulted in the research programme changing and developing were important in the

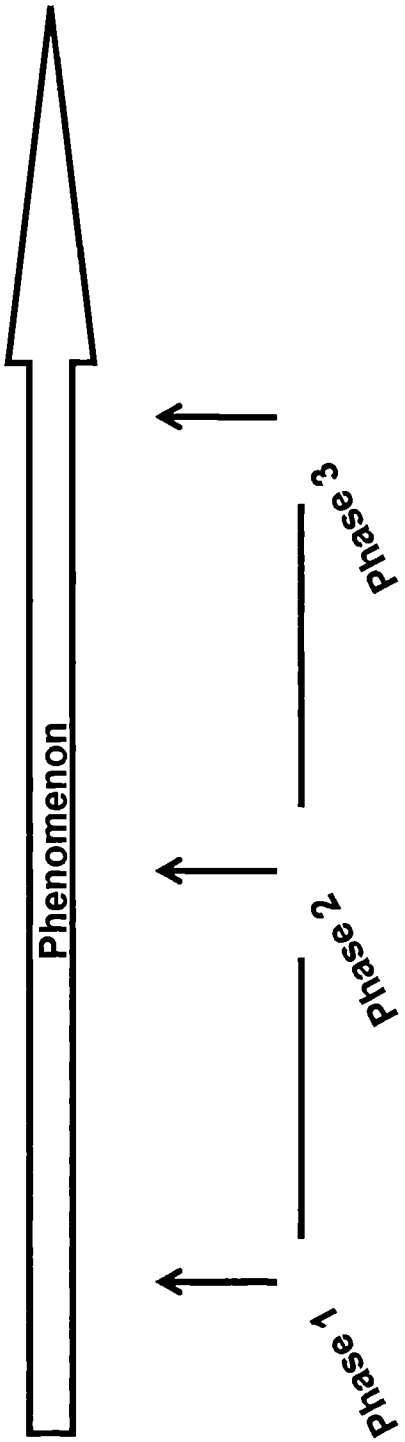


Diagram 6 The narrative thread- comparison with triangulation

development of the methodology of the narrative thread, indeed the thread was born of the process. This section will discuss the events which took place within the clinical area and give a brief outline of the way in which the phases which constitute the project became defined.

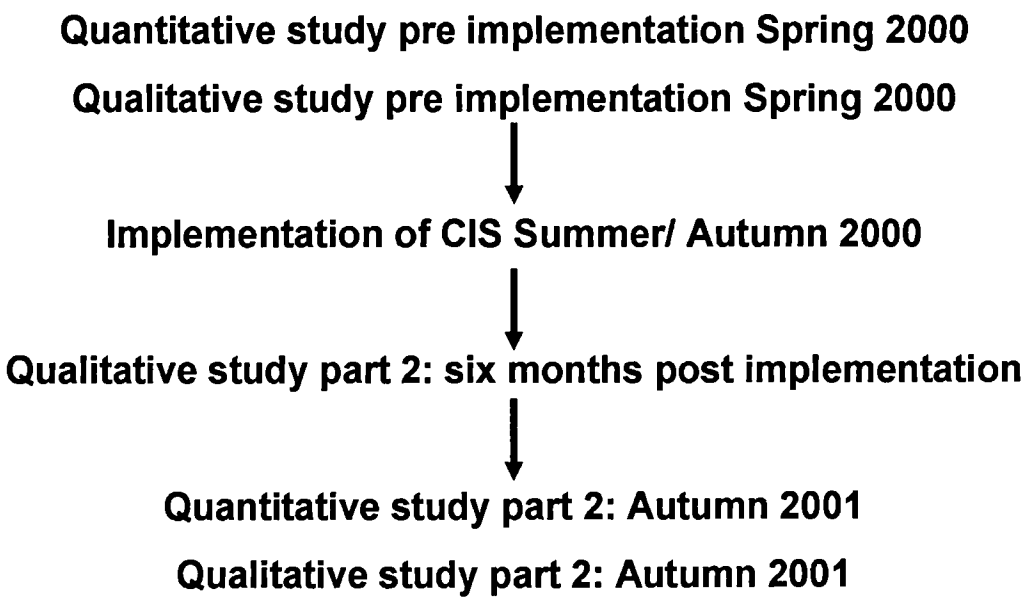
In 1998 it was announced that a CIS was to be purchased by Leicester Royal Infirmary NHS trust, for implementation in their critical care unit. The researcher had completed a Masters degree on a related topic and saw this as an excellent opportunity to pursue this subject further. Accordingly negotiations were entered into with the clinical managers to gain access and support for the research project. The negotiations were at times tortuous, but with help from the senior nurse manager and the senior medical consultant, a programme of research was decided with the following three conditions:

1. Any publications arising from the study would have to be co-authored with a member of the trust
2. Any publications arising from the study would have to be approved by the trust.
3. The programme of study would have to be integrated with the managerial evaluation of the system.

The first two conditions constituted significant constraints on publication, however they were not constraints on the research, which remained solely within the remit of the researcher. The third condition however did seem to potentially constrain the research. Fortunately, this effect was more apparent than real.

When the programme of research was initially proposed, the clinical area had not addressed the issue of evaluation of the CIS. Because of this, those involved readily adopted the broad outline of the initial research programme. This is summarised in diagram seven. Broadly it consisted of three phases. The first of these was intended to investigate the attitudes, aspirations and working practices of the critical care nurses within the local trust, prior to implementation of the CIS, by using both a quantitative and a qualitative phase. Following implementation of the CIS, a qualitative phase was to be used at six months to investigate the

Diagram 7 Initial research programme



change process and finally a repeat of the qualitative and quantitative investigations was to complete the project one year after the implementation.

The negotiations mentioned above revolved around not whether the research would be conducted, but by *whom* it would be conducted, and for a time it was unclear whether any space would eventually be available for the researcher within the project at all. Fortunately, when the extent of the project became apparent, a mutually acceptable accommodation was worked out, and although this was a rather time consuming and occasionally distressing process, the solution subsequently worked well. The initial research proposal was adopted, and super-imposed on this was a managerial evaluation of the system. The researcher was broadly in charge of the research project, with consultation included so that the two investigations ran in parallel. The managerial evaluation was in charge of a senior nurse who had responsibility for the specific evaluation of the system for the NHS trust. It was agreed that all information obtained from all elements of the study should be available to both workers.

In terms of this project this was felt to be a good compromise. Advantages included the adoption of all of the initial proposed elements of the study, with the added bonus of access to the evaluation data, should they contain findings or information supportive to the study, plus complete access to the research site. The disadvantages comprised a lack of complete autonomy in the questions and topics to be explored, plus the presence and participation of a senior nurse within some of the interviews.

A submission to the NHS Trust research committee was made in November 1999, which was subsequently approved. The researcher obtained an honorary contract with the NHS trust to facilitate access to the clinical area and to any relevant data.

Although the NHS has been described as having no worse a record in successfully implementing computerised systems than commercial and other government sectors (Smith and Smart 1999) this could be described as damning with faint praise. At the research site it was decided to purchase a CIS from Spacelabs, a North American company. This was to be the first time the system

had ever been implemented. The system was purchased and a senior nurse employed on a part time basis to work with the system to configure it to the needs of the ICU. This proceeded from spring to autumn 2001. During this period it was decided to run a pilot implementation of the system on two bed spaces which would employ parallel charting i.e. the system would automatically record data and the nurses would also manually chart recordings.

At this point severe problems with reliability, during which the system would freeze or crash became apparent. This proceeded for a period of three months when the decision was taken by the senior medical consultants to halt the implementation and to refer the whole project back to the manufacturers. At this point it became evident that the original plan for the research project was not viable, and the research questions would have to be answered by different means.

Maintaining the narrative thread by revising the research project: an overview

Clearly in the presence of a failed implementation it was necessary to cast further afield in order to address the research questions. The first stage of research gathering had already taken place before the issue of the non implementation had occurred, comprising the qualitative and quantitative studies 'pre implementation' (diagram seven). In order to maintain the focus of the research the quantitative investigation will not be pursued further and its results will not be included in this work. It was a development of the research outlined in Norrie (1997b) and would only have added to the narrative thread when compared with working practices following a successful implementation of CIS. Fortunately, the qualitative investigation remained relevant and formed the first research phase in the revised programme (diagram eight). This set of interviews contained baseline information which formed the basis for the revised research design. It addressed the first research question by exploring the hopes, fears and aspirations of the nurses questioned for CIS. It is primarily inductive in nature.

By using a grounded theory approach, this forms the first fissionary step in the narrative thread. If the narrative thread works, all the subsequent research

Diagram 8 Revised research programme

Phase 1

Semi structured interviews at pre implementation site

Phase 2

Open interviews at site where CIS was discontinued

Phase 3

Questionnaires using Likert scale comparing CIS site with non CIS site

methods contained within the revised research design should form a coherent narrative which will be used investigate the research questions.

To achieve this, the *second phase took place at a site where a CIS had been* used, but was subsequently discontinued. It too is primarily inductive in nature. This might therefore help provide material which could answer both of the research questions. The third and final phase of research uses the information derived from phases one and two and uses quantitative methods to apply these findings to practice, to help answer the second research question. It was therefore intended as a primarily deductive investigation.

Thus uniquely, the phenomenon of CIS will be examined from three perspectives, which may be able to answer both research questions, representing an original investigation which will provide an original contribution to knowledge.

Application of grounded theory methodology within the project

There are some problems associated with using grounded theory in practice which require addressing. Firstly Barney Glaser and Anselm Strauss developed markedly different interpretations of the processes of grounded theory. Glaser (1992) felt that Strauss and Corbin's publication of 1990 was too procedurally based and by providing a step by step guide to data collection, actually went against the open ended and inductive approach of the framework. The split in the grounded theory camp therefore could be described as being between theorists (the 'Glaserite' perspective) and pragmatists (the 'Straussian' perspective). This raises the issue of 'which' grounded theory to choose from. For the first research phase, it was decided to choose a middle path, using procedural guidelines drawn from both schools. It was hoped by pursuing this policy to obtain the best of both worlds: to have a procedural framework derived from Strauss and Corbin (1990) which was easy to follow and would also be able to maintain the open agenda and sensitivity of a 'Glaserite' interpretation.

Perhaps the split between camps should not be over emphasised. For example, their discussions on data analysis contain many similarities. Both camps identify three forms of coding of data in order to allow a reductive process. These work with a large body of data, interpret it and then lead on to the development of

new theory. The first of these, open coding, is a word by word, line by line analysis of (in this case) the interview data. This process is designed to fracture the data and then to group them into conceptual units that both emerge from the data and fit within it (Glaser and Strauss 1967). The significance of open coding is to allow categories to emerge from the data rather than impose already constructed ones upon the data (Grbich 1999).

According to Strauss and Corbin (1990), the next step is the application of axial coding. If open coding is a process which fractures the data the next step must be a process which puts the data back together to produce new categories, which can be used for the generation of theory. Although the development of axial coding as a concept is clear, Strauss and Corbin (1990) use a procedurally complex procedure which they call 'the paradigm model' to link the categories together in a set of relationships. Highly simplified, the model involves denoting causal conditions, phenomena, context, intervening conditions, action/ interactional strategies and consequences. Thus, to apply axial codes five sequential processes must be included. This, it could be argued, is unnecessarily complex, but such a criticism must be justified. Firstly, perhaps Glaser (1992) has a point, in suggesting that Strauss and Corbin (1990) have concentrated too much on the development of a procedural method and because of this have lost sight of the concept of grounded theory (Melia 1997). Secondly, other authors have identified similarly rigorous stages in coding, for example Dey's (1993) assignment of categories and Miles and Huberman's (1994) stage of pattern coding, without being so procedurally directive. However, by moving away from the prescribed method of Strauss and Corbin (1990), the researcher is at risk of including findings which may be judged as lacking rigour.

For the second phase a more rationalised interpretation of grounded theory was used. Smith and Biley (1997) similarly looked at grounded theory and achieved a remarkable synthesis, indeed it could be argued that they achieved something that neither of the originators of the methodology achieved. They developed a reasonably straightforward guide to using the model without becoming either too prescriptive in terms of procedures, a criticism of Strauss and

Corbin (1990),(Glaser 1992), nor too mystical and convoluted (Melia 1997). Smith and Biley (1997) achieved this by using a simple technique to explore the methodology. They developed a step by step guide through the major terms of the grounded theory methodology, but then discussed each component in broad terms only, allowing rigour by explicitly including all the major components, but also allowing freedom to the researcher in applying these to their own work.

From induction to deduction

The first two phases of the research are therefore inductive. A number of authors identify that an inductive approach produces hypotheses which are generalised in nature and are also predictive (Selltiz et al 1976; Roberts and Burke 1989; Bowling 1997). In terms of an original contribution to knowledge this represents both strengths and weaknesses. The strengths include the generation of novel ideas which can be applied to a range of computerised systems within nursing, the postulates not being confined to specific CIS products or health care settings, within critical care at least. In addition, the predictive nature of the theory generated implies that they can be used to analyse what would and what would not make CIS attractive and acceptable to the nurse users. The disadvantage is that the findings produced thus far have not been tested. Tashakkori and Teddlie (1998) identify that there is an interdependent relationship between inductive and deductive processes within research. Without a deductive phase of research to test out the inductive findings, the research project is not a whole. Tashakkori and Teddlie (1998) also identified and classified a number of mixed method research designs. They found that a qualitative then quantitative sequential mixed method design was a popular choice, because the qualitative phase allowed discovery of data from relatively unexplored topics, using the results to design a quantitative phase of projects.

It is intended therefore that the final phase will be deductive and will use the material already generated by phases one and two. It is intended that using these findings 'in the field' would give some indication of their fitness for purpose, as well as being one more component helping to investigate the original research questions.

Ethical considerations

In terms of the ethical considerations necessary for this project, all three phases shared some common properties. Firstly, at no point were patients identified nor were identifiable patient data used. Secondly, at no point was any aspect of patient care changed in order to yield data. Thirdly, the nurses involved have been kept anonymous and cannot be identified from the research writing. In addition, none of the fieldwork was covert, neither were sponsors involved, beyond it originating within a university PhD project. Therefore to some extent the ethical implications for this project were minimised (Homan 1991; Grbich 1999). However there were still significant areas which needed to be considered.

Following the Nuremberg trials after World War Two, the Nuremberg Declaration (or Code) was produced to avoid a repeat of the Nazi quasi-medical atrocities which had occurred within concentration camps, atrocities wrought by doctors and nurses. The Nuremberg Declaration is seen by a number of authors as being a defining moment in the clarification of ethics into research upon human subjects (Homan 1993; Tarling and Crofts 2000). Following this, in 1964 the 18th World Medical Assembly adopted the Declaration of Helsinki which gave guidance to physicians conducting research upon human subjects. The most recent amendment was adopted by the 41st World Medical Assembly in Hong Kong in 1989. This amendment stated that:

> *' the design and performance of each experimental procedure involving human subjects should be clearly formulated in an experimental protocol which should be transmitted to a specially appointed independent committee for consideration, comment and guidance'* (quoted in Tarling and Crofts 2000 p99).

Following this, most UK health districts and trusts set up a Local Research Ethical Committee (LREC) to consider applications for ethical approval, through which access to clinical areas and the patients and staff within them are guarded. These committees therefore were the principal point of contact for the three research phases within the project.

As an equally important consideration, the author of this project is a nurse registered within the United Kingdom, interacting with fellow nurses through the project and as such was bound at the time of the field work by the code of professional conduct of the United Kingdom Central Council for Nursing, Midwifery and Health Visiting (UKCC 1992a), although this has subsequently been superseded. Whilst it is true to say that the main thrust of the clauses within the code are aimed at protecting the clients, rather than the various health workers so covered, it also gives guidance to the ways in which the various health care professionals interact. As a principle, within the code each practitioner was constrained to act at all times in such a manner to:

> *'safeguard and promote the interests of individual patients and clients, to serve the interests of society, to justify public trust and confidence and to uphold and enhance the good standing and reputation of the professions'* (UKCC 1992a p2).

As an ethical consideration, the main thrust of this research project work is consistent with upholding these aspects of the code. Although none of the research phases changed aspects of current patient care, the intention of the work was clear, to identify whether CIS can support nurses in their clinical practice, and under what conditions this would operate. Certainly, any changes that eventually follow from the research will be incremental rather than revolutionary, but that in no way negates the intent.

Another consideration originating within the code was that of collaboration. The code states that collaboration and co-operation between health care professionals is also necessary (UKCC1992a). Therefore as a nurse, interviewing and negotiating with fellow professionals, an attitude of openness was adopted. Whilst this is necessary in terms of obtaining informed consent, it was decided by the researcher at an early stage that for successful and productive co-operation, positive relationships were necessary and the contributions of informants were positively responded to. Indeed as can be seen in some of the interview transcripts, at times the interaction between interviewer and interviewee became a discourse. Whilst there may be potential pitfalls in this approach in terms of exposing a research agenda which might add aspects of bias, it was felt that it remained a necessity to provide a collaborative experience in order to work productively with peers.

As a general statement then, it seems that the research project is likely to be ethical. However, more specific analysis is required. The Belmont Declaration (1978) was produced by the National Commission for the Protection of Human Subjects of Biomedical and Behavioural Research in the USA. It identified three primary ethical principles on which standards of ethical conduct in research could be based: beneficence, respect for human dignity, and justice. The commission considered how these general principles could be applied to practical research. They put forward three practical criteria which ethical research ought to achieve: informed consent, a favourable risk / benefit assessment, and appropriate non-oppressive selection of subjects of research. These components will be used to assess the ethical suitability of the research.

In summary, the forum of the LREC provided the main mechanism to instigate ethical consideration and clearance, the UKCC (1992) code of conduct influenced the attitudes expressed within this process and the applied criteria of the Belmont Declaration (1978) will be used to analyse the ethical status of the research phases.

Phase one: Semi-structured interviews at the 'pre implementation' site

Of all the research within the project, this was arguably the most problematical investigation. The possible ethical constraint is apparent when events within the clinical area are examined. At the time, the CIS was imminent and so it could be construed that managerial and organisational weight was behind its introduction. This could be interpreted as pressure to participate and to be positive about the introduction. In addition for approximately half the interviews a senior nurse was present, reinforcing the possibility that the project was 'on behalf' of the service management. The essence of informed consent is that the subjects should be able to agree or refuse to participate in the light of comprehensive information concerning the nature and purpose of the research (Homan 1991).

Therefore to minimise the likelihood of an interpretation of coercion, an information sheet was produced (appendix 1) which explained the aims of the project, the uses which the information would be put to and what would happen if individuals declined to take part. The content and format were

subsequently adapted and used for the other research phases, and therefore will not be included as appendices.

To address the Belmont Declaration (1978) criterion of suitable selection of subjects, the nature of the sample should be considered. This was a group of adult health care professionals working within a demanding clinical area. Intensive care nurses have been shown to be adventurous and positive in response to challenge (Maloney and Bartz 1983). They clearly are not a vulnerable group such as children, the socially disadvantaged or the elderly as described by Punch (1986) nor as identified in the Belmont Declaration (1978) itself. The Belmont Declaration (1978) further suggests that a criterion or standard of 'the reasonable volunteer' should be met, and this group could confidently be expected to meet this requirement. This assumption is supported by two observations. Firstly, one member of staff did decline to take part, and of course this was in no way prejudicial to their status within the unit. Secondly, within the interviews a wide range of responses towards the CIS are identifiable, from the very positive, through the tentative to the frankly sceptical. Staff evidently did feel free to express their concerns.

The final criterion is that there should be a positive assessment of benefits against risk (Belmont Declaration 1978). The case for the benefits has been made. The identification of risks is less clear, partly because they are intangible. There were two possible categories. Firstly, in order to undertake the interviews, the nurses had to leave the bedside of the patients. Because of the highly dependant nature of the critical care environment this could be hazardous for the patients, and in fact on a small number of occasions, interviews had to be rescheduled due to the workload on the unit making it unacceptable to take nurses away. This possible risk therefore was self limiting. In addition, because the project was given support by the nursing management, a senior member of staff was made available to cover for staff during the period of a number of the interviews. Thus one aspect of risk was managed successfully. The other possible aspect is that the interview process itself could be upsetting for the respondents. Whilst it would be unwise as to dismiss this as impossible, it remains unlikely. The CIS is potentially emotive in that it could significantly change the ways in which the nurses work, however at no point are what Blaxtor et al (1996) described as 'sensitive

questions' utilised e.g. issues of age, race or sexuality. Instead, the questioning was focussed on professional issues and the nurses' responses to potential changes within the clinical environment.

The proposal for this first phase of research went uneventfully through the local LREC.

Phase two: Unstructured interviews at the 'discontinued' site

The ethical implications for this investigation were less charged. Management was not involved and there was no prospective implementation of a CIS. The sample size was self selecting i.e. there *were* only four nurses available with suitable expertise, and all *four were willing to take part, following receipt of a* letter giving information regarding consent, and a description of the interview format.

The proposed research was discussed with the nursing manager of the unit, who in turn discussed it with the chair person of the local LREC. Because of the small sample size and the nature of the material to be discussed it was felt that it was not necessary to formally go through the committee, instead chair's action was sought and given.

Phase three: Quantitative questionnaires at the 'active' site

The questionnaires were given to an inclusive sample of all the qualified nurses at the three sites studied. An information sheet was supplied stressing that participation was voluntary. A cover letter was used to answer questions about the research (based on the information used in phase one) and contact numbers were given for both the lead researcher and a local contact number. To encourage respondents to complete the forms, a 'post box' was instituted at each site so that regardless of shift, the questionnaires could be handed in, again encouraging a non coercive attitude. The questionnaire design was approved by Oxfordshire LREC, and in the light of it passing scrutiny it was also sanctioned by the senior nurse manager in Leicester with responsibility for the other two units involved.

Ethical issues: the final word.

The Belmont Declaration (1978) stresses that there should be a formal assessment of risks and benefits for any research project which deals with human subjects. It is hoped that this exploration of the topic has shown that in this project for an extremely small risk, a significant benefit may follow.

However, this case can be taken further. Both the Belmont Declaration and the Helsinki Declaration (International Council of Nurses 1996) refer to the protection of human subjects of research, whereas it can be argued that there is another level of protection within this project. Rather than this being a research project *using* human subjects, this is intended to be a research project which *involves* and is *supported* by its subjects, in that it aims to explore topics of interest to the nurses involved, resulting in findings that will further help to develop aspects of their professional life.

Thus although it is hoped that this section has addressed in detail some of the important ethical issues, it is also felt that because of the construct and intentions of the project, the work itself is fundamentally ethical, both in intent and execution.

Phase one: Semi-structured interviews at the 'pre implementation' site

Introduction

It was essential for the first step within the project, that good quality non reflexive data be produced which would allow unbiased identification of the issues surrounding CIS which were of relevance to the nursing staff. As discussed in chapter three, it was intended accordingly that this phase of the research would be inductive and influenced primarily by grounded theory. Through this process it was hoped that an original perspective on the nurses' aspirations and concerns could be gained which would serve as a sound basis for the rest of the project.

The study

The adult critical care unit of Leicester Royal Infirmary represented a valuable research opportunity. At the time of planning the research, nursing staff were aware that it was intended to introduce a CIS. As preparation, a pilot implementation was in use at two bed spaces and most staff therefore had some experience of the capabilities of the system. In addition, a senior nurse involved with the implementation process had already disseminated information about the system, through both formal and informal teaching sessions. Thus the nurses were primed: the CIS was on the agenda for the unit, their awareness of it had been raised and they had knowledge of its capabilities.

Methods

Glaser and Strauss (1967) do not specifically analyse the merits of different methods of data collection in their seminal work on the framework of grounded theory. Instead, Glaser (1978) specifies that suitable sources can be from various forms of fieldwork such as survey, experiment or case study data. However in both these sources, the discussion on theory generation is based around the analysis of texts obtained from direct contact with subjects.

A number of strategies might be suitable to provide these texts. Certainly quantitative methods were not appropriate, being too limited in their ability to allow the subjects to develop their own ideas (Silverman 2000). By contrast,

amongst qualitative methods, interviews if conducted properly, have been identified with the production of 'rich' data, which can possess both subtlety and sensitivity (Gillham 2000b). In addition the interview format has been shown to be an appropriate technique for revealing information about complex subjects and for probing the sentiments which might underlie an expressed opinion (Seltiz 1976). This is relevant to the topic because the implementation of CIS would affect the way that every nurse within participating critical care units worked. Furthermore, interviews can be used to obtain in-depth insight into topics, drawing on deeper information, albeit from a small numbers of informants (Denscombe 1998). This depth of information was necessary to form the initial step in the research project.

Design

Interviews come in several varieties. Different authors use different classifications of interview type and format. For example Politt and Hungler (1993) distinguish between unstructured, semi structured and self report techniques. Grbich (1999) similarly suggests that interviews can be informal, guided or structured, but also maintains that it is possible to select and combine types within fieldwork. Gillham (2000b) uses a simpler approach by suggesting that the idea of a structured/ unstructured dimension is false. Instead he suggests that all interviews will have open sections (for example introductions) and sections which specifically address the research interests of the interviewer. Other authors agree with this. Denzin (1989) suggests that the interview, apart from being the favourite 'digging tool' of the sociologist, is like a conversation: there is always an element of give and take between the participants. Similarly Holstein and Gubrium (1995) find that *'all interviews are interactional events'*, where both parties are *'necessarily and unavoidably active'* (p4). Two elements were required. Firstly the interviews had to be focused on the nurses, their work and what they expected from the CIS. However, once this focus had been established, in order to produce non reflexive data, there had to be freedom for the nurses to express their views. Therefore a semi structured format using open ended questions seemed promising, because it contained both structure and freedom within it (Denscombe 1998).

Finally the concept of theoretical sampling must be addressed. This

can be related to a relatively formal agenda of open ended questions in two ways. Firstly, although the questions within the agenda were outlined beforehand, they were also broad. This meant that in the interviews, although the same major question categories were explored, within the series as a whole emergent areas could be pursued as the sequence of interviews continued. This was however not a formal arrangement, and will be discussed later as a limitation on the research. Secondly, the interviews were only the first component in a scheme of research methods. Therefore it could be argued that the theoretical sampling was provided by the verification or refutation of the research findings in the subsequent phases, i.e. the complete narrative thread structure allows formal inclusion of theoretical sampling.

Participants

The research setting has already been mentioned. In many ways it represents a typical critical care unit. It is situated within Leicester Royal Infirmary, a large (1500 beds) East Midlands teaching hospital. Admissions to the unit are derived from three main sources, the accident and emergency department and the surgical and medical wards. In scale with the hospital setting, it is a large (12 bedded) critical care unit. The unit is roughly split between six intensive care and six high dependency beds, but this division is flexible depending upon the needs of the patients. At the time of the research, the unit employed approximately 90 whole time equivalent nursing staff to care for the 12 beds.

Sampling

It was decided by negotiation that the interviews should be randomly stratified. Stratified sampling aims to obtain a greater degree of representation than straightforward randomisation, by subdividing the population into subsets (Polit and Hungler 1993). The element of stratification was introduced because three main groups of nurses who would use a CIS were identified. These were described by their clinical grading. Typically, a grade D nurse will be recently or newly qualified and have a limited experience of work within the clinical area. The nurse is unlikely to have obtained any post registration courses or other training in critical care nursing. A grade E nurse, by contrast is likely to have been within the speciality for a number of years and will have formalised his or her position as a critical care specialist by the completion of a specific post registration course such as the ENB 100 General Intensive Care course,

until recently the 'gold standard' of critical care courses. Lastly, the grade F nurses, who receive the honorific title of 'Sister' or 'Charge Nurse' will have many years of nursing experience within the clinical area with perhaps a number of specialist courses and roles. They will also include a managerial element in their work, such as regularly co-ordinating shifts. Clearly nurses within each of these categories may have different and valuable perspectives on the use of CIS. The stratified random sampling was intended to ensure that all three grades were included and constituted a representative sample. Strictly, this represents a disproportionate sample, which risks a lower precision of analysis (Bowling 1997). However, it can be argued strongly that these three grades represent three distinct user groups and although numerically there may be differences in their presence with, and usage of, CIS within the clinical area, each group has important and legitimate needs (see also Kaplan and Duchon 1988). These may be different, but all three need to be addressed for CIS to support the totality of the nursing within the clinical environment. The nurses who worked at grade 'G' were not included because the largest proportion of their work is managerial and therefore they would not be major users of a bedside system.

The sampling population therefore was the total of all the qualified nurses within the critical care unit working within the D, E and F grades. Accordingly a copy of the nurse rota was obtained and split into the three sections according to grade. A randomised sample between each stratum was obtained by the trusty method of allocating numbers to the staff names and drawing lots from a hat. Four nurses from each stratum were obtained by this method. To some extent this number is arbitrary. In general, the larger the sample size the more accurately it will reflect the population. However researchers are often limited in their resources. It was felt that a total of twelve interviews was the largest sample that could realistically be dealt with, not so much in terms of the interviews themselves, but in terms of the large amount of data that were produced by the transcription of the interview tapes.

Having obtained a list of names, permission was sought from the members of staff to take part in the interviews. A consent form was sent to each of the participants together with a copy of the interview schedule. This allowed the participants firstly to view the questions beforehand and hence support the

obtaining of a valid informed consent, and secondly to allow them to reflect upon any issues which they felt might be relevant beforehand. It was felt that this might encourage a greater depth to their replies within the interview.

All but one of the staff gave permission to proceed, and a replacement was obtained by a further random selection.

Measures

A schedule of questions was compiled by negotiation and is given in table 16. The questions were generated from four main sources. Firstly there was an element of benchmarking. The attitudes of critical care nurses had been largely unreported in the literature. It was intended therefore that the interviews would generate data that could be used as a basis for further exploration of the topic. For example, the questions concerning sources of satisfaction, dissatisfaction and general attitudes surrounding the use of computers, were generated largely by this concern. Secondly the research questions, introduced in chapter one, were examined and their constituent components isolated. For example, the second research question ('can CIS support nurses within critical care?') produced the questions concerned with the perceived advantages and disadvantages of the current methods of documentation, as these would be areas of nursing activity which would be significantly changed by the CIS implementation.

Thirdly a number of the questions were influenced by the available literature. For example, there are reports of nurses being intimidated by computerisation which has been seen as giving orders to the staff (Large 1994). Issues such as these would be picked up in the questions which addressed expectations and perceived disadvantages. This is fully compatible with a grounded theory approach. As Strauss and Corbin (1990 p51-52) relate: *'the literature can be used to stimulate theoretical sensitivity... and can stimulate questions'*, as long as this is acknowledged and incorporated within the design. The final source of questions derived from the managerial evaluation of the system. This accounts for some of the more closed questions used latterly in the questionnaire.

Despite the disparate sources used, through a process of negotiation, a reasonably coherent interview schedule was produced which was harmonious with this research project. Indeed it could be argued that the addition of a

Table 16: Schedule of questions used in phase one: Semi structured interviews at pre implementation site

1. Tell me about yourself and your career
2. Working in ITU, what gives you satisfaction about your role as a nurse?
3. What causes you dissatisfaction?
4. One of the obvious features about the Critical Care environment is the amount of technology involved in patient care – how do you feel about this?
5. What do you understand by the term information technology/computerisation?
6. How do you feel about the traditional method of patient data collection, documentation & charting system?
7. What do you perceive are the advantages with using the current methods of documentation? Can you list up 3 main advantages and which of these is the main one?
8. What do you perceive are the disadvantages with using the current methods of documentation? Can you list up 3 main advantages and which of these is the main one?
9. What do you know or understand about the CIS implementation in the ITU here?
10. Do you have an understanding what the capabilities of CIS are, if so what are they?
11. What are your expectations of CIS?
12. At this point in time, do you perceive any advantages with using the CIS?
13. At this point in time, do you perceive any disadvantages with using the CIS?
14. How do you think that the current use of IT/computerisation within the unit affects your role as a nurse?

number of 'wild card' questions was a strength, opening up the agenda of the interviews to topics which had not been identified in the literature, the research questions or the benchmarking, countering the potential hazards of reflexivity.

Thus even in this first investigation some elements of methodological triangulation were introduced.

Procedure

Interview training is important to limit the introduction of bias (May 1997). As a qualified nurse with ten years of experience in practice, it could be argued that the researcher's interpersonal skills had already been developed through training and interaction with clients and relatives. In addition, experience had been gained in interviewing potential students for university courses. This included incorporating equal opportunities legislation within the fabric of an interview situation, and encouraging students to identify their own needs and express their opinions. These skills would be broadly supportive of the research interview experience.

For specific preparation a Master's level module on research methods run by De Montfort University was undertaken, which included analysis of videotaped examples of interviewing techniques. Some of the guidance from this was then incorporated in rapid review of the tapes from the first two interviews undertaken in phase one. The aim of this exercise was to identify impediments to the expression of views from the subjects, a common problem for inexperienced interviewers (Sarantakos 1997). As a result, modifications to technique such as greater tolerance of silences and appropriate junctures at which to probe respondents were identified and consciously adopted.

In addition, the possible personal bias of the researcher should be addressed. Formal techniques to limit this were not employed. This is because the researcher had made no investment in the evaluation of the CIS. Very positive, lukewarm or very negative data would all have provided data for the generation of theory. However it should be noted that theoretical sensitivity had been developed by exploring the literature surrounding CIS. It could be suggested that this process in itself could be biasing, in that prevalent views could be subliminally assimilated. However, the only bias that was consciously brought to the project was the perspective that much had been discussed about the benefits of CIS and their impact upon nurses, but little had been proven. If the content of the interviews is considered, this is unlikely to be a

source of bias because this does not impinge upon the main narrative of the interviews. This is because the interviews do not examine the effectiveness of existing CIS at all. Instead they explore what the nurses wished, or feared that the systems would do for them and how they felt they would affect their nursing care. However, bias within a proportion of the interviews is likely have been introduced by the presence of the senior nurses involved with the managerial evaluation and this, together with any bias derived from imperfect interview technique, will be addressed in the limitation section in chapter nine.

The interviews took place between March and April in the year 2000 in a seminar room adjacent to the critical care unit, which was reasonably quiet and could be made free from interruptions. Participants were encouraged to bring a refreshment with them and an informal atmosphere was fostered. As outlined in the consent process, a tape recorder was used and this was clearly visible to the interviewees. Approximately half the interviews were undertaken by the researcher alone and half were undertaken in conjunction with the senior nurse involved in the CIS implementation. Initially it was expected that time would be a constraint, bearing in mind the external demands of the critical care unit on its staff members. This is reflected in the early interviews, where it was suggested that fifteen minutes each be allocated to the questions raised by the research project and the managerial evaluation. However, during the course of the interviews two factors became evident. Firstly the interviews seldom ran as long as thirty minutes, instead the majority lasted between 20 and 25 minutes. Secondly the two components were not equal parts. The set of questions dealing solely with the research project produced much more data than the evaluation questions. In fact as the interviews evolved what emerged was an interview of two distinct parts. The broader, more wide ranging, questions of the research project generated the majority of data, which were then brought into a sharper focus through the evaluation questions. One further benefit of this serendipitous arrangement was that it allowed full use of the semi structured format: participants were encouraged to explore aspects of their contributions without undue pressure of time and without the interviews being so long as to be burdensome.

Transcription of the tapes was made by an experienced audio typist. Transcription symbols were not used. Initially it had been planned to obtain the

transcripts and to review them and add symbols. Thus the tedium of transcribing large amounts of text could be avoided, but the detail to be found within the interview tape could be conserved (Silverman 1993). However, upon review of the tapes it was decided not to pursue this. A trial use of symbols was undertaken on two of the tapes, but in fact did not appear in any way to provide more information or support a deeper understanding or analysis of what had been reported. Therefore it did not represent an efficient usage of the researcher's resources. However, in order to support accuracy, the transcripts were all reviewed in Microsoft Word 97 and compared with the tapes. Amendments and corrections were made by the researcher to support quality (Gillham 2000c), although it was noted that the initial transcriptions were of a very high quality.

Analysis of the interviews was undertaken using a simplified grounded theory approach, based upon Glaser and Strauss (1967) and Strauss and Corbin's (1990) description of methods as discussed in the methodology section. This was done by a thorough reading and re-reading of the interview transcripts, combined with attaching memo labels to the phenomena encountered within the text (Miles and Huberman 1994). For example in the interview transcript, following the collection of demographic details, the first true question was based upon the theme 'working in ITU, what gives you satisfaction about your role as a nurse?' This generated twenty open codes including '1:1': the high ratio of nursing staff to patients, 'FOL': the ability to follow the patient's progress through their stay, 'ILL': the high degree of illness amongst patients and 'CHAL': the challenge of looking after critically ill patients. These are termed conceptual labels by Strauss and Corbin (1990). Application of these labels was not achieved at a single review of the interviews, but as codes arose it was necessary to re-engage with the data on a number of occasions, as the emerging categories coalesced and separated.

Having engaged with this process, a text of 41,000 words was condensed to 159 different conceptual labels. The incidence of open codes was recorded on a matrix in line with the techniques of Miles and Huberman (1994), in order to provide an easy to interpret display to maintain maximum granularity in the data, combined with the possibility of identifying themes specific to the three different strata of interviews undertaken.

To promote validity, an independent co-reviewer was employed to parallel the coding and generation of categories. This was a senior research nurse at a local hospital, who spent considerable time and effort in going through the transcripts independently, before a comparative analysis with the researcher's findings was undertaken. Secondly, having discounted Strauss and Corbin's (1990) method, rather than opting for an informal generation of axial codes, a compromise was sought for. Both Glaser (1978) and Strauss and Corbin (1990), suggest that three processes are involved. Firstly, the coding system was continually refined as it became apparent that the initial codes were just that: an initial attempt to order the data. Secondly, as the data were viewed and reviewed, theoretical memos were produced. Both Glaser (1978) and Strauss (1987) describe this as the central phase of data analysis. Memos at this stage of data analysis were used to record relationships within categories, therefore they reflected successful and sometimes unsuccessful attempts to link connections and thereby helped generate axial codes (Strauss and Corbin 1990). Lastly there was the integration of emergent categories. Here the main objective was to synthesise emerging categories by creating links between them. These three processes proceeded until the data were 'saturated', i.e. until no new category was generated from the data (Strauss and Corbin 1990). This then was the process that was utilised to analyse the data from the first research method. The final step in the data analysis was to use the axial codes to generate theory, as discussed in the methodology section.

In summary, the interviews were conducted using methods derived from applied grounded theory, constrained to some extent by the managerial evaluation which was taking place. Analysis of the interview texts took place using an adapted grounded theory analysis. What will be presented in the next section is a report of the data findings based upon open and axial coding of the data. This will provide a level of conceptual theory.

However, the final stage of analysis is the production of axiomatic theory. The ways in which this can be achieved is illustrated in diagram five. What has been described so far are the steps of 'fieldwork one' and 'analysis one.' The final step of 'synthesis one' calls for the application of knowledge gained from the literature review to the axial data. This will allow a formal

incorporation of theoretical sensitivity and it is intended at this stage to encourage the development of axiomatic theory.

Results

A full transcription of the interviews is presented in appendix two.

Data analysis

The analysis will follow the interview scheme previously described, with some exceptions which will be discussed as they occur. The first item to consider is the demographic nature of the sample. As discussed, stratification of the sample was used to represent the three main consumer groups who would use the CIS on a daily basis. By chance all three of the clinical grade groups were made up of three females and one male, a reflection on the predominantly female nature of the profession, albeit with a significant male minority. Within the D grade nurses, the time spent within nursing ranged from two months to four years, the time spent within critical care was between two months and two years. Two of the nurses had worked in other care environments, two had worked solely within the unit where the research took place. One of the nurses (who had spent two years on the unit) was undertaking a degree incorporating specialist critical care training.

Within the E grade nurses, the time reported as spent in nursing was between eight and eleven years, whilst the time spent within critical care units (not necessarily the research site) was between two and nine years. Three of the sample reported a specialist qualification in critical care nursing however no mention was made of other training. Amongst the F grade nurses, the time spent within nursing was reported as being between six and eight years, with a minimum of six years being spent within the specialty. All had specialist critical care qualifications, with one reporting that he had worked abroad.

Sources of satisfaction

The majority of respondents identified issues relating to the high quality of care that they delivered as being major sources of satisfaction. Staff Nurse E described this:

'I like to see the work I plan in the morning being completed by the time I go home and the patient progressing from being really ill to doing really well.'

This idea that 'at the end of the day' the nurse will have satisfaction from delivering good quality care was widely reported by other staff members. The ability to provide such high quality care was seen as being related to the opportunity to deliver one to one nursing care (i.e. one nurse caring for one patient only throughout a nursing shift), this was mentioned repeatedly (12 mentions) across all three grades. This was also reflected in a number of respondents describing the nursing care that they delivered as 'holistic', although none of them actually defined the term, therefore the exact meaning of the appellation is uncertain. However a number of the respondents reported throughout the interviews that caring for the patients from admission to discharge was an important aspect of their work, and so it could be interpreted that this continuity of care, with the nurse being the central agent of ensuring the continuity, is an important feature of the role. Perhaps a good working definition was supplied by Staff Nurse J who described what she meant by 'one to one' nursing:

'You deal with that patient as a total whole and there is usually a lot going on with the patient as well in all different aspects and it can be with different specialities as well.'

As an extension to this discussion, the opportunity to support family members through the patient's illness or recovery was noted. Amongst the more senior nurses, the related ideal of being in a unique position to deliver high quality care was reported, and again this was explicitly related to the high staff to patient ratio. As Charge Nurse C reported:

'the satisfaction comes from both one to one nursing and also the amount of input that we have with the patient's relatives. That gives me a lot of job satisfaction as well.'

In addition the privilege of being able to help provide a dignified death for patients and relatives, or conversely to watch patients get better following critical illness was identified. Although this was reported across all three grades, it was most prevalent amongst the D and E grade nurses. For example Staff Nurse H noted:

'If we can't make them feel better, then it's giving them the dignity and the privacy to be poorly, or if necessary to die with dignity. I also see it

as looking after the family as well though, especially in intensive care, it is a huge part of our remit to look after the family.'

Another source of satisfaction was identified by the more senior members of staff. They reported that working within the multidisciplinary team was a source of satisfaction, as was the acknowledgement of their skills and expertise. Throughout the wider cohort of respondents, the clinical environment was held to be stimulating, the workers were reported to be high in morale and more autonomy was allowed to the nurses when caring for their patients, than in less acute settings. It was however noted that this could be challenging:

'you have always got to be on top of things, you have always got to be thinking ahead, prioritising and I keep myself up to date' (Sister D).

Similarly, it was reported that working with critically ill patients was exciting.

To summarise this initial section, the main category which emerged from the data was that the critical care environment was highly rated by all of the group, because of the quality of the nursing which it allowed them to provide. The factors which contributed to this included caring for patients and their families from admission to discharge, which was linked to being in a one to one relationship with the client and was therefore related to staffing levels. In addition, the professional environment was important, with acknowledgement within the multidisciplinary team of the skills of the nurses being rewarding, especially amongst the senior grades, as were the personal challenges of caring for critically ill patients. These are novel findings and will be important in the synthesis of axiomatic theory in the next section.

Sources of dissatisfaction

The senior nursing staff, at grade E and F, were most able to identify sources of dissatisfaction. Indeed one of the junior nurses could not identify any source of dissatisfaction at all! This gives some measure of the success of the unit as a whole in protecting the junior staff from the pressures of working within what is acknowledged as a stressful environment (Norrie 1995). It also suggests that the clinical area was a supportive and cohesive unit.

Amongst the more senior members of staff, pressure on the nurses due to high workload was widely noted. Within the F grade Sisters especially, high bed occupancy was noted as a problem, this was also felt to be related to

staffing levels and to skill mix. There are a number of inter-linked issues within these observations. One of the major sources of satisfaction identified earlier was the ability of nurses to deliver high quality care. This is potentially constrained by these factors. Bed occupancy refers directly to the number of patients within the unit at any one time. Less directly, it also refers to the very labour intensive process of admitting and discharging patients. For example, if bed occupancy stays high as is often the case, in order to admit one patient, another will need to be discharged to a ward. This involves explanations to the patient, the removal of intravenous and arterial lines, the completion of paperwork, including discharge summaries and the completion of care planning. When this has been done, the patient is escorted to the ward and handed over to ward staff. As Staff Nurse E highlighted:

> *'when doctors may say 'lets get this patient to a ward in an hour' and they just really haven't got a clue what is involved. That makes me really mad sometimes.'*

Staff Nurse G also reported:

> *'I'm discharging a patient this afternoon and I must have spent an hour sorting out, writing out forms and copying charts and it's ridiculous!'*

Similarly skill mix was a constraint. Skill mix refers to the abilities and skills of the nurses which make up the staff on duty. The more critically ill a patient is, the more highly skilled the nurse who cares for the patient will need to be. If a significant proportion of the work-force is provided by relatively inexperienced nurses, then pressure is placed upon the senior nurses to support the junior nurses. Therefore both high bed occupancy and inadequate skill mix will add to workload issues as possible sources of dissatisfaction. This is likely to provide a tense situation which prevents the nurses realising their main source of satisfaction: that of delivering high quality care. As Sister A put it:

> *'ensuring safety ... sometimes it can be quite difficult from the point of view that you are trying to organise and ensure that everybody is cared for properly and that the staff are supported, but if the resources are a little bit thin you don't always succeed in delivering the standards that you want to achieve.'*

As has been suggested, the critical care environment is a stressful one. Sources of stress were identified by the F grade nurses as aggression from

confused patients and families, and the futile prolongation of life. Interestingly these pressures were not reported amongst the lower grades, suggesting again that the environment was protective towards the junior members of staff. Finally, there were reports of breakdown of communication amongst members of the critical care team. This included communication amongst the nurses, but more evidently a mismatch between the medical and nursing staff. In the words of Staff Nurse I:

> *'the doctors from other areas actually coming on to the unit, they just wander on, look at the patient, "yes, that's all right" and sort of disappear without actually communicating as to how they feel the patient is progressing and what the next plan of action is and obviously they may tell the patient one thing but not bother letting us know so we end up, as the old story goes, we end up picking the pieces up when they have told them something tragic.'*

This was reported across all three grades. Finally, it was acknowledged that at times it was not possible to give the support to the junior staff which would have been wished or required, and this again was related to workload. High workload and poor skill mix therefore come across as being the two main factors that arise consistently when considering sources of dissatisfaction. If CIS can help ameliorate any of these sources of dissatisfaction, they can potentially support the nurses in delivering their care. This will be addressed in the synthesis section of this chapter.

Technology in the clinical area: positive attitudes

Interpretation of this question is an important issue. The nurses appeared to use the term 'technology' to include two sets of equipment. Firstly, they identified a group of medical devices such as ventilators and syringe drivers as 'technological' in nature. In addition they identified the IT aspects of the patient monitoring or laboratory reporting systems as fitting within the term. Therefore, any distinction between the two was not really made, suggesting that the nurses adopted a pragmatic analysis, being willing to adopt any piece of technology that could help them to deliver their patient care, regardless of its provenance.

For example modern ventilators and other devices are also driven by embedded microprocessors and provide extensive patient information

displays, so really the term technology can be applied quite widely to encompass both aspects of 'technology' (i.e. machines which do things for patients) and 'information technology' (i.e. machines which deliver patient data). This broad interpretation will be used throughout this report.

As a general statement, the staff were positive about the potential of technology to support patient care within the critical care area, albeit with some important limitations. A large proportion of the sample (two at F, all the E and three of the D grade nurses) reported that they felt technology was a useful tool which helped them look after their patients. They identified patient monitoring systems, ventilators and fluid administration devices as supportive technology. For example, the ways in which modern ventilators have made it easier to ventilate and promote patient comfort was noted by Sister A:

'Well, ventilators for example. Ventilation modes have changed and make it a lot more easy to ventilate a patient and they require less sedation and it is more comfortable for them.'

Similarly, Sister B summarised a theme raised by a number of the staff:

'Yes it is a lot of technology, but at the end of the day it is a necessity ... the patient needs it and the patient comes first and the technology supports the patient.'

Echoing this theme, it was identified that some nurses were passive about the role of technology: they had just accepted it as a part of the environment and took it for granted that it was a tool to assist in their delivery of care. In the words of Staff Nurse K:

'I suppose, maybe its different for other people, but I am only 21 and I have used a lot of technology in my schooling as well, maybe I'm more used to it, you know I see it as part of life, so I am just getting used to it really, I accept it.'

However, three nurses reported that they had been attracted into the clinical area by the presence of technology. Technology therefore was largely seen as a positive and supportive feature of the environment, as long as it was used with discretion and did not dictate the course of the nursing. As Nurse G said

'I think that's where technology and experience should work together, I don't think it should be all technology. I think your experience is really important.'

To summarise, nurses were generally acceptant of the technology but more specifically placed a positive value upon it when it supported their patient care, underlining the pre-eminence of the role of delivering high quality patient care noted earlier.

Technology in the clinical area: negative attitudes

Some similar themes emerged when considering the hazards of working in such a technological environment. The staff worked every day with technology, and so were aware of some potential pitfalls of this alliance. It was identified that it was possible to become too focused on the technology to the detriment of nursing care, there was a possibility of a 'Frankenstein effect', where the technology became the master rather than the servant. For example, Staff Nurse H said:

'well I think sometimes we have to stop and think what we are doing. Sometimes I think we use too much technology on patients that probably don't want it.'

To support this she cited the case of an 87 year old patient with dementia who was ventilated post operatively. As she concluded:

'I think we should have, I don't know, a conscience I suppose.'

Similarly, Staff Nurse G identified that:

'I think that a nurse's clinical observation is more important than technology, but I think that you have to use them both in this area to be safe with your patient.'

Amongst the D grade nurses, it was identified that initially the amount of technology had caused some anxiety. However, it was also mentioned that because they were relatively young, they had been brought up with computers and so, it was reported, assimilated it easily.

Amongst the broader cohort, poorly implemented technology was identified as being especially undesirable. Within the unit, blood results were accessible through an antiquated computer link with the pathology laboratories. As Staff Nurse I put it:

'Nine times out of ten you can't actually get into the computer screen, it sort of comes up with a different starting message and you can't actually get it into the directory that you need it to be in to get your results back and then obviously it relies on the people at the other end having put the results in for you to gain access to... if it doesn't function properly, it's a pain in the bum because then you have to spend twice as much time chasing it up anyway.'

The frustration of this flawed communication medium was evident. This was reinforced by Sister F who remarked that:

'we have that computer that we have for the lab results which nobody seems to be able to function and if that is anything to go by then we are going to be in big trouble!'

It is noteworthy that this sentiment was not expressed elsewhere and despite the drawbacks of the current unwieldy system for delivering results, it did not appear to dampen the willingness of the nurses to consider new technology as a possible support in their patient care, this is an important issue which will be influential in the production of axiomatic theory.

Finally, training was seen as an important issue amongst the F and E but not the D grade nurses. There are two possible explanations for these reports. Firstly, this group of nurses were of an older cohort and had not 'grown up' with computers. For example Sister B noted:

'People need to be trained adequately to use it. They need to know how to use it because people are notoriously frightened of computers. I myself, particularly, I have never grown up with them, so the training for them needs to be put in place and structured, and if that is all done, they will be able to be used accurately and well'.

Therefore they might have been more cautious about the effort required to assimilate computerised technology within their practice. Secondly, because of their more sophisticated knowledge of the working conditions within the clinical area, the senior nurses might have been expected to be more wary about the amount of effort required to train all the staff within the clinical area. Despite these reservations, it was noted that again the nurses were generally positive about what technology could do for them, provided it was reliable and easily accessible. If it did not satisfy these two criteria then it was felt likely to

be a hindrance rather than a help, an important aspect of their attitudes which will be influential in the generation of theory.

Definitions of IT within the clinical area

The application of the term 'information technology' was defined in three ways. Firstly, staff across all three grades identified IT as being able to provide important data which could be used to support patient care. The way in which these data could be brought together was also noted, as Staff Nurse F said:

'for me computerisation is trying to bring everything together on ... a screen in front of you, without having to go into the into the corners of the unit to find that information, or to go to numerous different people to try and find that information.'

This idea of increasing the accessibility as well as the improved quality of the information was also noted by Charge Nurse C who identified that a lot of nursing time was spent in documentation and this time could be freed up by using IT systems to record data, again with the understanding that this extra time could be used to deliver more care:

'Presumably it is going to free up our time because we spend a lot of time every hour charting and documenting things, so hopefully it is going to free up our time to actually give care as opposed to doing some paperwork.'

The second definition equated IT specifically to the use of computers within the clinical area, and again it was identified by two nurses that the majority of hardware within the environment could already be described as 'computerised', that is it utilised embedded microprocessor control.

Finally a number of emotive issues were identified. Two of the more senior nurses reiterated that they had not grown up with computers and this raised concerns for them with the increasing presence of computerised systems. Previous unfortunate experience with IT had also made some of the nurses concerned with the reliability issues of computers when used to support patient care. It was also felt that despite the provision of IT, human skills must remain central to the care of patients within this environment.

'I see it as an instrument to help me care for my patients. At the end of the day they are paramount and it is tools really that help make your work easier.'

Traditional charting systems

A notable split was found between two aspects of the traditional recording and charting in use at the research site. This compared the large 24 hour charts used to record patient observations with the ancillary paperwork consisting of (amongst other items) medical notes, nursing notes, laboratory results and admission and discharge summaries.

Across all the clinical grades, it was reported that the 24 hour charts were generally seen as being a useful source of information, allowing an adequate record of the patients' status, which was readily available and held together in one place. It was felt that the chart contained a lot of information within a compact format, which was preferable to separate documents which would be unwieldy. For example, all the major observations such as the ventilatory and cardiac parameters were reported as being present *'at one glance.'* It was noted, again across all the clinical grades, that the staff found the charts easy to use because they were accustomed to them, and they felt confident in using the data from the charts. In addition, it was observed that the chart encouraged vigilance, in that the machinery and monitoring had to be checked every hour and parameters recorded every hour. However limitations were also identified. Charge Nurse C said that:

> *'They are very time-consuming. They only show that particular, you know, they are on the hour, they don't particularly show us what is happening in-between-times and if we did want to document that, it is extremely difficult to document it and make it legible. The chart tends to become a mess and you don't get any information from it. And, you know, its not giving us a complete story really, so it is just a snippet every hour that we are charting, that we are documenting'*

These feelings of frustration were echoed by Sister D:

> *'I feel that, particularly like admission things, they are very repetitive. We write things down, (*noise on tape*) writes the same thing down, the ward then writes the same thing down and we could admit a carotid from the ward for a few hours and we write everything down again.'*

In summary, although of use in the retrieval of patient information, the 24 hour chart was widely held to be time consuming. The chart could be messy,

illegible or generally difficult to interpret. It was noted that the chart only provided a snapshot 'on the hour' and that therefore not everything that happened to the patient was recorded. This meant that it could be difficult to look back and identify previous events, investigations or procedures.

Finally, amongst the more senior staff, confidentiality was held to be a concern, due to the physical prominence of the charts. The junior nurses identified fewer disadvantages than the other two groups, perhaps due to inexperience of alternative charting documentation.

In general then, the nurses were positive about the 24 hour charts, viewing them as useful resources in the way they delivered care, albeit with some reservations. In contrast, however, they were unqualified in criticising the ancillary paperwork which included patient notes and various separate result sheets and forms. No member of staff could identify strengths associated with the current recording of these aspects of patient data. It was reported that the ancillary paperwork was repetitious, especially when admitting or discharging patients, which required copying information by hand. In particular, the laboratory result sheets were unwieldy as sources of information and the pre printed care plans did not encourage individualised care planning. This disparate collection of data became even more unwieldy and time consuming when the patient was due to be discharged. In the words of Staff Nurse E:

'You would rather be there caring for them than ...sitting at the end of the bed writing out drug charts, forms and copying TPR charts out which... go to the ward and end up being filed and never looked at again anyway, so it's a pointless waste of time, isn't it?'

Finally, because of the many different pieces of paper involved, the ancillary paperwork was reported as being prone to getting lost.

What staff hoped to gain from using CIS

At the time of the interviews, it was believed that the implementation of the CIS was imminent. Although it was part of the compromise of gaining admission to the research setting, the inclusion of a set of questions to explore the extent to which the nurses were aware of the capabilities of the system remains a useful source of information. A number of the questions which were used fed into each other and covered the same conceptual ground (Questions 7-13 table 16). Therefore this report of the findings will

amalgamate a number of responses to produce a more functional account which is conceptually linked.

Perceived advantages of using a CIS

This section will explore the issues which the staff anticipated as the possible capabilities of the CIS. They identified improved documentation and accessibility of information to be desirable goals. It was widely identified that the majority of the patient data would be stored within CIS. It was thought that this central store of information would allow ready access to important information by nurses, medical staff and other members of the multidisciplinary team. The nurses were very positive about the quality of the information that would be available, noting that the accurate recording of data would support legality and safety issues and would be able to speed up and make more efficient the discharge and admission of patients to and from the unit.

For example Sister B noted that:

'if it works well, ..., we can do audits from it, we can get all the information that we need from it and get rid of all the numerous pieces of paper that are duplicated ten times over on the unit that all say the same thing.'

Unsurprisingly, given the weighted nature of the questions used to generate these data (Questions nine, ten and 11), these were positive findings.

However, they can also be viewed as a comparison to the current manual methods of charting: the alternative or tacit interpretation of the question being 'in what way can the CIS change or improve the way that you currently nurse'? As identified previously, shortcomings in the manual recording had been noted. Although staff were generally positive about the 24 hour chart, they were very negative about the ancillary paperwork which accompanied it. This set of responses seems to support this analysis, in that the nurses identified CIS as a possible useful adjunct to centralise, arrange and make available this information to inform nursing care.

As well as data management issues, across all the grades of nurses, there was a groundswell of opinion that CIS could save time for the nurses and this time could be translated into improved patient care. This was reported across all three grades and was mentioned serially by a number of interviewees.

As Charge Nurse C noted:

' presumably it is going to free up our time because we spend a lot of time every hour charting and documenting things, so hopefully it is going to free up our time to actually give care as opposed to doing some paperwork.'

Similarly Staff Nurse F felt it could make discussion concerning patient management more efficient:

'so I am hoping that it will be time saving and just easier to view if somebody comes along and asks you for information that you would be able to press a few buttons and show, if say the surgeon comes along and asks you for information, then you would be able to show him relevant information.'

More widely, it was hoped that the system could cut down on repetitive paperwork and by centralising information would make it more readily available. A number of the nurses, again across all three grades, reported that the current care planning documentation could be streamlined and made to be more patient specific and responsive to the individual needs of the patients. These observations suggest that the nurses, in anticipation, were positive about CIS.

In addition to these workload issues, staff felt that CIS could have a direct impact on patient care. It was thought that assessment of patients could become more continuous, rather than an activity which occurred once every hour, when the twenty four hour chart was filled in. Despite these positive expectations, the nurses were also readily able to identify possible concerns relating to the CIS. These are important possible outcomes which can be looked for in further phases of the research, to determine whether CIS really can live up to the expectations of the nurses.

Perceived disadvantages of using a CIS.

A large proportion of the staff were concerned about reliability, more specifically that the system would 'crash.' This was again reported across all three grades. The reliability of the recorded data were also mentioned as being uncertain. As Staff Nurse I put it:

'you only get out of the computer what you put into it, so obviously you might get one person that uses it really well, but then somebody else

who doesn't put the information in... it depends on the people that are using it as to how well it will actually work back for us.'

Three members of staff were concerned that by using CIS, an important step in data management might be omitted. With manual data recording, the staff were actively required to note and interpret the data before recording it. There was concern that in contrast, with the automatic acquisition and recording of data, that this cognitive step would be lost, and so 'contact' with the data would be reduced. This was reiterated in the observation that the reliability of the data might be an issue, or that different individuals might use the system differently, again casting doubt on the veracity of the data. For example Staff Nurse K felt that

'it would be that people wouldn't maybe monitor the trends so well as if they were writing it themselves every hour'

Finally, the possibility of a Frankenstein effect was again identified, more specifically that the system might be too didactic. As Staff Nurse E put it:

*'it will come up on the screen and it will tell you when to give you Cefuroxime (*an antibiotic*), I don't want a machine to tell me when to give my Cefuroxime!'*

He explained this further:

'I think we have got to always remember that a lot of what we do is based on human skills.'

Final issues

Although it was always the intention of the researcher that the interview questions would be non directive in order to allow an honest inductive approach, this was potentially limited by the second set of questions, included as the managerial component of the interviews. In order to re-establish an open forum it was decided to finish the interviews with a portmanteau question, to allow the respondents to raise any issues which had not previously been covered. This question was centered on asking the nurses about the ways in which computerised technology affected the nurses in delivering patient care.

In general this final question did not raise many new issues. Some professional development concerns were identified. For example, one member of staff identified that by using new equipment, the staff were kept up

to date. Similarly it was felt that to keep up to date with equipment required personal commitment. It was also mentioned that the pace of change within the critical care environment was an important issue: it was a challenging environment. However, the majority of comments remained positive. Again it was noted that staff often did not necessarily notice the equipment, it was accepted as *'sort of a partner in crime really, sort of a partner in care'* (Staff Nurse G).

More specifically it was noted that the technology aided safety and made life easier within the clinical area. Concomitantly, some negative aspects were also identified. It was reiterated that some of the current aspects of technology were poorly executed, and once more a number of respondents referred to the lamentable system for reporting laboratory results. Training was raised as an issue, it was pointed out that if insufficiently trained, patient safety could be compromised. Finally one member of staff identified that noise levels within the unit due to alarms on the equipment added to the stress of the environment.

Synthesis of phase one findings

This is the final stage of the first cycle of the narrative thread. Thus far, a process of data reduction has occurred to arrange, summarise and describe the large volume of the interview material. As diagram five (page 101) predicts, this section will be used to apply insights gained from the literature review to the research findings, in order to identify whether axiomatic theory can be generated.

As discussed within the methodology section, axiomatic theory contains two components, a truth or connection and the operational conditions under which the truth operates (Frankfort-Nachmias and Nachmias 1996; Bowling 1997). A suitable starting point might be to consider the terminology of the phenomena under investigation. Within the fieldwork, a number of questions were put to the interviewees which aimed to focus consideration on their use of the complex machinery, technology and sources of information used within the clinical area (questions four, five, ten, 14 in table 16). In their replies, the nurses did not appear to differentiate between the different equipment which was predominately characterised by IT, such as the monitoring systems in place, nor that which was predominantly characterised by mechanical

functionality such as the ventilators or syringe drivers. Therefore the terminology referring to 'IT' or other forms of 'technology' presents a limitation to analysis, as the equipment referred to by the nurses contained, to some extent, both of these elements. In other words, to produce unambiguous theory, equally unambiguous terminology is a prerequisite. Applying a blanket term which would loosely include these (and possibly other elements) would not be helpful. For example a term such as 'functional technology' would not be satisfactory, because this could equally be applicable to automotive technology and it has already been identified that to derive axiomatic theory, conditionality must be included. This also would clash with the principle of the research being grounded within the clinical area.

Commonalities between both ends of the spectrum can be identified. From the interview material it can be identified that the principle feature identified by the nurses was not primarily related to the physical or specificational nature of the equipment, rather that it was capable of being applied within the clinical area to support patient care. The technology was reported as *'a necessity'* , the *'patient needed it'* and it was *'a partner in crime.'* However, having introduced this perspective, distinction would then have to be made between a secondary set of features, so that for example bed linen or other resources relevant to patient care were not included. These considerations were that the equipment was technological in nature and included elements of IT. In order to clarify the discussion all these aspects of the supportive technology will be subsumed within the term 'Client Applied Information Technology' or CAIT. This novel term needs to be tested to determine if it is a useful addition to the debate surrounding the use of computerised equipment and if it helps in further analysis of the findings.

It was suggested in chapter two that the two main groups who wrote about the use of technology within the clinical area were speaking in two languages. To be successful, the term CAIT would need to be comprehensible in both. This would be a useful contribution as it could help dialogue in future between the two groups. Its derivation from nursing goals has already been discussed, therefore it can be suggested that it works within the nursing language. It does also appear relevant to the mechanistic goals of the promulgators of CIS, indeed a CIS would be a good example of CAIT illustrating the sort of impact

which it can have on patient care rather than purely on information management. Therefore as a term it seems to be functional and may indeed be useful.

It can also help in answering the research questions of this work. If it is accepted that nurses use their own language to identify their goals, what are they saying? Again the literature reviewed in chapter two suggested that the nurses were closely focused upon caring for patients and communicating with them (Cody 1988; Crawford et al 1998; Hardy et al 2002). This is clearly supported from within the interview material, for example when reviewing the section on sources of satisfaction. This actually brings together two aspects of theory derived from the literature review. Firstly the nurses are in possession of their own language of care and are clear that they can use CAIT to support its goals. Secondly, these goals seem to be very close to the category of 'Direct Nursing Care' (DNC) derived from the five-fold analysis of the quantitative studies in chapter two (Norrie 1997b). This is a bold statement and must be substantiated since it brings two radically different methodological worlds into close contact. Consider table ten (page 36) which shows the definition of DNC used by Norrie (1997b). Within the interview materials it is identified repeatedly that it is the ability of the critical care environment to allow nurses to focus on these aspects of care which is the single most satisfying element of their work. This includes communication with patients and their relatives, helping their colleagues and being in a position to care for all the patients physical and psychological needs. Indeed this delivery of quality direct patient care can be described as the nurses 'primary aim' and this is the second piece of novel terminology to be introduced.

Other interview material supports this line of argument. Firstly, when reviewing the work of Barley (1986) it was suggested that application of CAIT could result in opportunities for renegotiating relationships within the workplaces. It was similarly noted within the interviews that appreciation of the contribution of the nurses to patient management by other members of the multidisciplinary team (principally medical staff) was a source of satisfaction. However, within the interview material this case was not developed further. The nurses did not report that the anticipated CIS implementation was an opportunity to change working relationships. Instead the use of a CIS (and

hence logically other aspects of CAIT) was again seen primarily as an opportunity to further their pre-existing primary aims. Similarly, the application of the theoretical work of Trochim (2000) suggested that there could be a multidimensional nature to the attitudes of the critical care nurses. However, this was also not supported by interview material. Indeed, the contrary view becomes more clear. The more the responses are engaged with, the more it is found that the nurses see the main issues as being remarkably *uni*dimensional in nature, and that dimension contains only their primary aims. The identification of CAIT as being potentially able to support the primary aims allows the proposition of the first element of theory. This will be termed an axiomatic hypothesis. The definition of axiomatic theory has already been addressed. The term 'hypothesis' has been chosen using the definition *'a supposition or proposed explanation made on the basis of limited evidence as a starting point or further investigation'* (Oxford Concise Dictionary 1999 p700). The intention is that the concluding analysis of the project will bring all the hypotheses together to produce sound theory. This is also in line with the terminology and practice of Strauss and Corbin (1990). The first axiomatic hypothesis is:

'critical care nurses will support the use of CAIT if it allows them to deliver better quality direct nursing care.'

The strength of this statement lies within all the elements being closely defined: the nurses, the form of the technology, and the use of the five-fold system classification has resulted in an unambiguous statement. The weakness of the statement is that at this stage it remains tentative. Fortunately it does not stand alone, although it remains to be discovered whether the further in the project can either support or refute this statement.

More conclusions can be drawn from the data. The nurses within the interviews showed themselves to be generally on a continuum between passive and positive about the roles of CAIT. This was arguably for two reasons. Firstly although they could identify that CAIT was an important partner in the care which they delivered to their patients, they were also wary that it should be used appropriately rather than the nurses becoming subservient to it. It can be suggested therefore that the idea of the *tabula rasa* (chapter two) may have some appropriate qualities as a model to explore the

nurses' acceptance. Consider the properties of a clay tablet, smoothed and ready for imprint. The tablet will take an imprint from any appropriate implement. Similarly from the interviews it appears that the nurses were willing to consider any implementation of CAIT. However it is the content of what is written that is really the key to the *tabula rasa*. When proposing the concept, it was initially expected that once the tablet had been written upon, the imprint would be fixed. However if the instance of the poorly implemented laboratory link is considered, it can be seen that this is not actually the case. Indeed, a prepared clay tablet *can* be smoothed over and used again, and this seems to be the case with the nurses willingness to use CAIT. It can further be suggested that in the desire to deliver their primary aims, the nurses are willing to wipe their tablets clean, at least on a number of occasions. This allows the generation of further ideas. Firstly, for this to take place, the nurses must be able to clearly see that there *are* advantages to their primary aims, and these must be sufficient to motivate them. Therefore the greater the potential advantages are, the more likely they will be willing to smooth the tablet. This is an important issue for anyone wishing to design or implement any aspect of CAIT. It further suggests that for the nurses to be acceptant, the implementation must not only clearly support their primary aims, but should also be expressed or communicated in the nurses 'language' and not the terminology of the technocrat (Garmer et al 2002). However there is (at least) one limitation to the analogy. The *tabula rasa* suggests that the nurses are passive in what is written down. This is clearly not the case. Throughout the interviews the nurses were found to be extremely discerning in their analysis of the use of CAIT. Therefore a paternalistic interpretation of the *tabula rasa* is not appropriate: no one else can write upon the tablet. Instead it is the nurses *themselves* who have the ability to inscribe and will do so dependant upon their own agenda and there is no evidence from the interviews to suggest that any other agenda is relevant. For example, a number of authors have suggested that CIS can support research and the production of databases (Millholland 1988; Lenz and Metnitz 1995), but this was not reported in the interviews. Quality of the delivery of the primary aims remained the essential goal. Therefore a second axiomatic hypothesis can be generated:

'The acceptance of CAIT by critical care nurses is not a once only or unique event, but can be built up by a number of favourable encounters which are defined in terms of the nurses' primary aims.'

Again the terms within the statement have been clearly defined, and again the weakness within the statement relates to the narrow base of evidence from which it is drawn. Therefore, as before, it is anticipated that the further steps within the project can be utilised to support or refute this statement.

Other considerations arising from within the data

Some other points arose, which are similar but are differently focussed and discrete in content. Firstly, within the interviews a number of positive statements were made concerning the 24 hour chart and it seems that the nurses found it to be a useful repository and source of information. However, the opposite was true of the ancillary paperwork, about which nobody had a good thing to say. Therefore if anyone is interested in enhancing the ways in which critical care nurses work by reviewing documentation, this would seem to be a good place to start. Certainly if a CIS was to be applied to the clinical area used within the research, it might be wise to look at ways of ordering these data manually first, because as Firth (1985 p14) memorably suggested

'applying technology to a manual mess only results in a technological mess.'

This is particularly true of the paperwork needed to transfer patients, which was widely held to be time consuming and wasteful. Indeed, for nurses and implementers in general it could be pointed out that although the purchase and installation of a CIS could be an exciting experience, it would be humbling to think that a significant number of its positive features could be achieved by a thorough review and ordering of the paperwork within the unit. This may lack glamour, but may also be extremely cost effective, and could similarly help the nurses work towards their primary aims. This gives rise to the third theoretical proposal.

'A thorough review and ordering of the paperwork within the unit can support a number of the nurses' primary aims'.

Because of the limited evidence to support this, it will be described as a theoretical memorandum which will require further evidence to support it. The use of this term is adopted from Glaser and Strauss (1967) and Miles and

Huberman (1994). It denotes conceptual material that may be influential to further discussion, but which on its own is not sufficiently strong to qualify as an axiomatic hypothesis.

Two other issues can be identified. The desire of the nurses to pursue their primary aims has been identified and remains the central core of the findings. However, there are related areas of interest which although they could not directly augment this process, could realistically be expected to be attractive, by making the nurses more visible and powerful within the clinical area. For example within the interview material it was identified that breakdown of communication, primarily with medical staff, was a source of dissatisfaction. If the implementation of a CIS resulted in the nurses becoming the guardians of patient information, then they would be more readily identified as key contributors and organisers of the care which the patients receive (Phillips 1993). Similarly if the communications within the multidisciplinary team becomes enhanced, nurses might make the connection themselves between better information and a more visible role in promoting patient care. Therefore two more axiomatic memoranda are proposed:

'CIS implementation can support communication, primarily with medical staff, and thereby increase satisfaction with the nursing staff'.

And:

'CIS can make the nurses more visible and powerful within the clinical area'.

However these remain tentative statements, which again may be supported or refuted by data analysis at a later date.

Conclusion

In summary, this section has shown that this first research investigation has raised many issues, some of which have been identified within the literature, but some of which are new. Therefore it is believed that it may already represent a modest but nonetheless significant contribution to this debate. What remains to be considered however is their applicability to real life situations within the critical care environment. Taking into account the rather narrow evidence base upon which the theoretical statements have been constructed, it is reasonable to conclude that all of them are tentative in nature. Further phases of research may be able to add support, or refute

them. Thus for the researcher, the narrative thread is a practical tool, it allows both for a more prolonged formative process in the generation of theory and also reduces the likelihood of unsupported and possibly spurious claims.

Phase two: Unstructured interviews at the 'discontinued' site

Introduction

The project design was devised in order to encourage flexibility in the investigation of phenomena, allowing the researcher to identify and use research opportunities as they arose, as long as they were able to further investigate and develop the findings of the previous research.

At Killingbeck Hospital in greater Leeds an interesting research opportunity was identified. It was unusual in that nothing similar had been reported within the literature. Within the cardiothoracic critical care unit, throughout the late 1980s a team of medical staff and computer experts had developed an 'in house' CIS. Some of the capabilities of this system have been reported in Crew et al (1987) and Stoodley et al (1992) and although not as comprehensive as some of the commercial products, in execution the system was not dissimilar. A comparison of the abilities of the different systems has been presented in the literature review (table three page 22). The CIS continued to be developed throughout the 1990s until the hospital was amalgamated into the larger Leeds General Infirmary. At this point, the cardiothoracic critical care unit physically moved into central Leeds and into new accommodation. However, the CIS was not successfully relocated and because of problems with cabling (and possibly a lack of political will) was discontinued.

The study

Although unfortunate for the staff who had been developing the CIS, there now resulted a unique population of nurses: those who had previously worked with a CIS and who now used manual methods of data recording. Clearly these staff could have very valuable perspectives, firstly on the research questions of the project and secondly as a source for triangulation for the first phase of research. The first investigation identified what the nurses hoped a CIS would deliver in terms of supporting their care, this could be confirmed or refuted by the second, or perhaps more interestingly two different agendas might be revealed.

Methods

An inductive qualitative investigation was again identified as being appropriate to explore the responses of this group. The reasons for adopting this general approach were identical to those used for the first phase, therefore the arguments will not be repeated here. Again it was decided to use interviews and a grounded theory approach to elicit unforced data.

Design

In some ways, the semi structured interviews of phase one were a formative process, and some of its limitations have already been discussed. The smaller sample size of phase two and the experience gained by the researcher, allowed a more formal adoption of grounded theory methods and its processes, such as coding and analysis as exemplified by Smith and Biley (1997) and discussed within the methodology section. This uses a five stage process, starting with the definition of the research question, features of grounded theory sampling, the contribution made by reviewing the literature, data collection, and analysis of the data. This is the structure which will be used here, with minor adaptation and re-ordering to allow incorporation of a conventional format for the elements of research method.

Participants

At Killingbeck hospital there were seven cardiothoracic intensive care beds. Nursing staff for this unit comprised approximately forty two whole time equivalents.

The move to Leeds General Infirmary occurred in October 1997. Nursing staff in critical care units are subject to a high staff turnover, reported to be in the order of 33% per annum (Pryor 1989). Accordingly, by the time the interviews were conducted, few of the original staff were left. There were only four members of staff within the cardiothoracic critical care directorate who had used the CIS previously.

Sampling

All four members of staff who had used the CIS were invited to participate in the research and all four accepted. Thus the sampling strategy was inclusive so far as was possible.

Smith and Biley (1997) suggest that with a grounded theory approach the size of the sample population is dependant on the expert knowledge of the

informants rather than their ability to represent a larger population. Their definition of theoretical sampling is based upon a process where data and analysis from early investigations are used to formulate further questions. This process continues until saturation is reached i.e. no new data emerges. Therefore theoretical sampling is highly desirable. With phase two, in comparison with phase one, this was a more achievable goal. Firstly, the sample and hence the data produced was more modest in size, secondly there was no pressure to adhere to the schedule of questions, and lastly the researcher had gained experience in both conducting and analysing interviews by this stage.

However, some constraint on this aspect was still evident. The sample size was extremely small, limiting sources of data, although Strauss and Corbin (1990) point out that theoretical sampling refers to incidents and not persons *per se*. Secondly, resources were an issue. The interviews took place in Leeds by a researcher based in Leicester with a full time lecturing post. Time was therefore limited and because of this, all the interviews were arranged to take place on one day. Clearly, this meant that between interviews a formal analysis of the data was not possible. However, by taking contemporaneous field notes during the interviews, it was possible to allow aspects of theoretical sampling. This was done by reviewing the field notes between interviews and identifying emergent issues. These were then influential on the subsequent interviews as long as they were concordant with the contribution of the interviewee.

The charting systems used by all four in their respective work stations at the time of the research was based upon the traditional 24 hour chart and ancillary paperwork as previously described. Their current work was based in both adult and paediatric cardiothoracic critical care.

Measures

Smith and Biley (1997) state that the research question in a grounded theory study is very different to the hypothesis generated at the beginning of scientific studies. The questions must be flexible and open ended to allow the theory to develop and should also be sufficiently broad to enable a thorough investigation of all the facets of a phenomenon, whilst still providing a focus.

To allow this a loose schedule of questions was drawn up and circulated to the respondents prior to the interviews (table 17).

Table 17: Sample of questions used in phase two: Semi structured interviews at from Leeds General Infirmary, the 'discontinued' site.

- Can you identify ways in which your nursing has changed now you no longer use a clinical information system?
- Has the change from a clinical information system affected your workload?
- Do you feel that your patient records and observations have changed in any way?
- Do you feel it has changed the way in which you relate to your patients?
- Has the change affected the way you communicate with other nurses or other members of the MDT?
- How has the change from a CIS affected you personally?

These were generated from review of the previous set of interviews and their subsequent analysis and synthesis. However, unlike the schedule for phase one, there was no pressure to adhere to these items. Instead the questions were given as examples necessary for informed consent, to give a broad idea of the topics to be covered, and to help the interviewees recall using the CIS. It was intended once discussion had commenced, to set aside the scheduled questions and to then allow significant topics to emerge, a tactic supported by Melia (1997).

Procedure

Interview preparation was similar to the arguments as outlined in chapter five page 126. In addition, experience had been gained throughout the previous phase which can be expected to add to the quality of the interactions.

All the interviews took place in a quiet side ward at Leeds General Infirmary. The tape recorder was clearly in sight and notes were taken throughout the interviews. In addition to the informant, only the researcher was present throughout the interviews. All interviews took place within a period of five hours. In practice time was not a constraint and interviews took between 20 and thirty five minutes.

Transcription and editing of the interviews was undertaken as discussed in phase one.

The analysis of the data proceeded using an adaptation of Smith and Biley's (1997) procedures. Firstly, they described open coding as a preliminary analysis:

> *'a tentative exploration of all the different facets that the analyst perceives as important or interesting in the text'* (Smith and Biley 1997 p21).

This was not achieved at a single reading of the data, instead it was an iterative process where the data were considered and reconsidered in the light of the different codes that were generated, until saturation was achieved. From this initial analysis, core (or axial) categories were identified. Smith and Biley (1997) identified three activities which helped the emergence of core categories, all of which were used.

Refining the index system

The initial set of codes was kept on index cards. As the development of codes reached saturation, so the significance of some became more evident. This reshaped the data and allowed a clearer understanding of its meaning to emerge.

Memo writing

The writing of theoretical memos is discussed and encouraged by Glaser (1978), Strauss (1987) and Strauss and Corbin (1990). It is therefore an activity recognised by the main progenitors of all varieties of grounded theory. Strauss and Corbin (1990) suggest that by reading, re-reading and then sorting the memos, it can be discovered how categories come together to form a core category, and this proved to be a very useful stage in the ordering of the data.

Integrating emerging categories

The end product of a grounded theory analysis usually takes the from of a set of completely saturated core (or axial) categories, developed from the initial (or open) coding, incorporating the refinements and memos discussed above. This was achieved using a matrix for data display as suggested by Miles and Huberman (1996). Therefore in this final stage of the analysis, there is integration of all the preceding steps to help the production of theory.

In order to support the validity of the analysis a draft copy was sent to the interviewees. Comments from this were considered and incorporated. A finalised draft was then produced and confirmed as being acceptable by all four.

Results

A full transcription of the interviews is given in appendix three.

Data analysis

The four respondents proved to be an interesting and vocal group. Since it was a number of years since the CIS had been in use, the nurses had since developed their careers and had graduated onto more senior roles and so had interesting perspectives related to nurse management, educational and patient management issues, which emerged throughout the interviews.

In many ways, Simon had been a pivotal figure in the development of the CIS, acting as a link between the nursing staff, the medical staff and the computer team who had developed the system. He described the development of the system from being one which was *'fairly basic just a way of logging the blood pressure and central venous pressure'* until, with the support and commitment of senior medical staff, it became a comprehensive system which replaced the paper chart. He saw himself as being in a position to advocate the needs of the nursing staff:

> *'it is a nursing chart, not a medical one, so therefore nursing must be involved from the outset.'*

Within the interviews however, there were some reservations about the system itself. Edwina had used an earlier and less sophisticated version of the system than the other members of the group. This had resulted, she reported, in a system which required duplicate charting, the system being part manual and part automatic. Unsurprisingly, she was the least positive about the CIS in the group. She reported that the level of resources invested in the system was inadequate:

> *'if you look at big industry, the amount of money they put into computerised systems, ours was like a joke in comparison.'*

Even Linda, who was largely positive (although with concerns) identified that the more sophisticated system itself would nowadays be obsolete and would require a lot of further resources to be further implemented. She also indicated

that when the cardiac units had moved in to their new accommodation, there had been some relief that the CIS had not been translocated, that this represented *'one less thing to be concerned about.'* This was also echoed by Simon who noted various problems with service provision in the new accommodation such as networking, which might have resulted in the system being rendered less reliable.

In general, Simon, Claire and Linda were largely positive about the CIS. Reflecting upon her experiences with the earlier version of the CIS, Edwina expressed reservations, although her negative experiences did neatly reinforce the experiences of the other three respondents.

The main theme which emerged from all four was the positive reaction to the use of a system which could save time and would result in more time being spent in delivering rewarding aspects of nursing care. As Linda reported:

> *'one of the main things is that it gave me time, I felt I had more time, rather than actually writing down the data itself you had more time to be actually analysing what was going on, being more involved in patient care.'*

As a nurse working within paediatric care she identified that *'talking to Mum and Dad takes a huge amount of time'* and is an aspect of care that, whilst extremely important, tends to be relegated due to other aspects of work. Claire too was extremely positive about the CIS.

> *'It was phenomenal, the amount of time I then spent with the patients. I wasn't spending hours looking at pieces of paper I was spending hours caring for a patient.'*

This was a recurrent theme. Claire felt that although time management was the biggest issue:

> *'the time that I gave to the patient was of greater quality because there was more time to spend.'*

Simon agreed, he declared:

> *'the first difference that you were aware of virtually immediately is the time saving aspect.'*

Although Edwina, possibly because of her exposure to a less sophisticated system had fewer positive experiences, her response was telling. She felt that

the CIS reflected its home grown origins and described it as not being '*slick*' or sophisticated. Because of this she found the CIS to be very time consuming and so got in the way of delivering the care and attention she would like to give to her patients. This is exactly the mirror image of her previous colleagues findings. She reported that with the CIS:

> *'I would have to go into this page and that page and something that should only take me a matter of seconds to get the information that I needed would take me a minute or longer to actually get and find it on the screen.'*

So strongly did she feel that, at times, the CIS hindered her care that she had deliberately crashed the computer in order to spend more time in caring for her patients. This response gives some idea as to the strength of feeling that a CIS could generate, although Edwina also declared that she would still be receptive to using a more highly developed system in future, *if* it supported nursing care.

This reinforces the theme that the nurses were generally in favour of the CIS *if* it liberated nursing time and *if* this time could then be used in delivering positive aspects of nursing care, such as caring for patients or relatives.

This is such an important theme that it is worth further elaboration. All the nurses, including Edwina 'the saboteur' wanted time to enhance the quality of their nursing care, and if a CIS could achieve this for them, they would be in favour. However the contrary would also hold, if the CIS could not deliver these desirable outcomes, then the nurses would not support the CIS. This is an interesting view which influences the *tabula rasa* discussion, which will be explored in the synthesis section.

This theme was further supported by the reactions of the nurses when forced into using a conventional paper charting system within their new setting and showed a level of internal consistency to their responses. Unsurprisingly given her prior experiences, Edwina reported that going back to manual recording was *'no problem'*: She was enthusiastic about this return since

> *'it actually increased the amount of time that you had to do what you needed to do.'*

The other respondents by contrast felt the return to a manual system was undesirable, albeit for exactly the contrary reasons. For example, Simon

reported that with the return to manual charting, the recording was inaccurate and he (as a senior nurse) had to spend time in interpreting and correcting more junior staff's records, whilst Claire, who had been a junior sister at the time noted that the conventional system

'required me to spend a lot of time monitoring patients and watching monitors to watch when changes occurred.'

This supports the proposition that it was time saving and the ability to use this saved time in patient care which was the central issue for these nurses.

However, time saving was not the only issue. As has already been discussed, the system itself was considerably less sophisticated than commercial systems. The more senior nurses identified an element of resistance amongst the junior nurses towards the system. This was crystallised by Linda, who although very positive about what the system could deliver, expressed some relief that the system was not in use at the new accommodation:

'For me at the time when we went back to the manual system, to a certain extent the initial thing was one less thing to be concerned about. We had come down here, we had new ventilators, new equipment, all the staff were very uptight about the move. It was a very traumatic experience for a lot of people who didn't particularly manage very well. I think they all found comfort, and therefore from a co-ordinator view, as long as the staff were happy with something, it was something that they knew.'

Similarly Claire identified that staff needed computing skills and that junior staff could be unsure as to how to use the system, which might in itself make the system unreliable. This suggests (along with Edwina's general cautionary stance on the subject) that the benefits which could be derived from the CIS are not guaranteed. Whilst it may be true that the CIS will be welcomed if quality of nursing can be delivered through time saving, the saving of time might be dependant on a number of factors, such as the abilities and sophistication of the system itself and equally importantly the attitudes of the staff using the system and the support in terms of training, suggesting conditionality in any gains which might accrue. This will be an important issue in the generation of theory within the synthesis section.

Claire had noticed how frightened people could be of the CIS and noted how easily things could go wrong with the system if inputting was not done correctly. She even reported *'people who were comfortable in pushing buttons willy nilly and causing the system to crash.'* She concluded that the most important thing is making sure that people have elementary computer skills. This suggests a tension within the findings. If the element of time saving remains the central issue, the acceptability or otherwise of the CIS is dependant on senior staff being available to help instruct junior and new staff in the use of the CIS. This in itself will require time, although Simon and Linda, being staff members who had invested time in setting up and using the system, both appeared to feel that this was time well spent. It could therefore be suggested that the different responses of the two members of staff who had less investment in the CIS, Edwina and Claire, were reflective of the success or otherwise of the training which had been undergone. In either case, training remains a large, potentially costly issue, if a CIS is to be implemented successfully. Therefore personal attitudes became important issues. As Linda said:

> *'it was very much who was at the end of the bed in terms of personalities and attitudes, beliefs, values whatever and there was a number of staff who were quite negative towards the system, they didn't like it. I would put that down, it's my own assumption, to be a lack of understanding with the system and despite going through the system, it was also a fear of information technology I would say..... I had to do a lot of time with them about fundamentals'*

Supporting this theme, Edwina felt that she had not been given proper IT training beforehand, but that given a well supported up to date system, with good quality training, she would be keen to use, or at least try a CIS:

> *'It's not turned me off technology but I think the problem that we had, we didn't have the finances to properly resource with people to do a proper computer system.'*

Edwina developed this theme later. When reflecting on the preliminary report from the interviews, she identified that the earlier CIS version which she had used had not been successfully implemented, that it had been imposed upon the nursing staff and that change management had not really been

addressed. She felt that these were important issues in influencing whether or not staff would develop positive or negative attitudes towards a CIS.

Two additional themes emerged from the data. Three of the interviewees (Simon, Edwina and Linda) identified that a CIS could be useful in assisting quality assurance, such as research and clinical audit. However, although this shows an awareness of these issues, none of them identified any research that had been carried out using the CIS or developed these ideas further. Therefore it seems that these possibilities were not central issues for them.

However as a final item, Simon identified an interesting perspective on the issue of time management. He felt that when the CIS had first been implemented, staff had been uncertain as to what they should do in the absence of a paper chart:

> *'You find yourself looking after your first few patients without a nursing chart, lost for things to do, twiddling your thumbs... because you haven't got that prop at the end of the bed, the nursing chart that you can be looking at or doing sums on.'*

Two points can be inferred from this. Firstly, describing the paper chart as a 'prop' is interesting and carries insight: it is certainly a central feature of the nurses' working life within the unit, and requires time and attention to be spent on it. Secondly, given that the CIS does save time, it does not guarantee that the time liberated is used effectively to support nursing care. Therefore this is another conditional feature of the use of a CIS and not an absolute. Although both Simon and Linda felt that the CIS changed the ways in which they worked. Linda, as discussed above, identified that with the CIS she spent significant amounts of time training staff to use the system and she also felt that workload could actually increase if people were unhappy with the system. Simon, as probably the member of the nursing staff most involved with the CIS, felt that without the system he had to spend a lot of time checking the paperwork of the more junior staff: instead of the data being *'clean and accurate'* they were back to:

> *'an old paper and pen type system where you are looking at things and trying to decipher squiggles.'*

As a senior nurse he identified that this changed the way he worked significantly, and was one of the main reasons why he was in favour of the

CIS. This point does again reinforce the conditional nature of the benefits which can be accrued from the CIS, and highlights both aspects of the central research questions of the research project.

Synthesis of phase two findings

The most consistent theme to emerge from the data was that of time management. Three of the respondents (Linda, Claire and Simon) were positive about the system, because they reported that it could save nursing time. One was negative about the system for precisely the contrary reason, because she felt the system consumed nursing time.

It is worth exploring this further. None of the quantitative studies were convincing in showing that time had effectively been saved by CIS (Norrie 2000). However there is evidence here that time, at least subjectively, could be saved by a *well* designed and *well* implemented CIS. By contrast time management issues were given low emphasis in phase one. For example some comments (such as those of Sister A) identified activities of data management as being time consuming, but did not explicitly link with this with the potential advantages of a CIS.

One possible explanation for this is that the group interviewed in phase one had not used a CIS and were therefore hypothesising, based upon their own knowledge and this may have been strongly influenced by the use of poorly implemented systems, such as the computerised laboratory link. Another possibility is that they were so focussed on their primary aims, that they conceptually overlooked the contribution to time management that a CIS could make. Be that as it may, the group interviewed in phase two were the only group thus far to have used a CIS. Logically their views when applied to the impact of a CIS in practice can take precedence over the 'pre implementation' respondents, as they could be described as being more experienced in the phenomenon of study.

The nature of CAIT implementations was also considered within the literature review. It was suggested that such technology represented a two edged sword, because not only could benefits flow from the system, but so too could harm (Demeyer 1967; Anderson 1982). This analysis suggests therefore that the majority of the respondents in this, the 'discontinued' site, had indeed found that the cost benefit relationship could be a positive one,

illustrated by not only this finding, but also by the generally positive responses throughout the interviews. However, one of the respondents (Edwina) felt negatively about the system because she felt (amongst other reservations) that it consumed nursing time. She did however identify that the system she had used was primitive, or as she trenchantly expressed, it was not '*slick.*'

Both sides of this debate therefore indicated that a *properly* implemented CIS could save time. However, having saved nursing time, it is necessary to identify what the nurses wished to do with it. A number of clues to this were given within the transcripts. For example Claire said that the saved time meant *'I actually had more time to spend at the bedside caring for the patient'* and Linda said she had used it to allow

> *'being more involved in patient care, being more supportive to parents and the families'* .

These statements are strongly reminiscent of with the discussion from the first phase of research, which produced the concept of the primary aims of the nurses, suggesting that motivation was similar at both sites. Similarly, these qualities are also related to the category of direct nursing care from Norrie (1997b), although in this phase differences do start to emerge.

Close inspection of the interview materials in phase two suggests that in addition to the activities of direct nursing care, elements of patient assessment were expressed by Linda and Simon as being desirable. As Simon put it 'being able to give more time to the patient and concentrate *on what is going on with the patient*' was important and as Claire said '(I was) sure I had the right answer *when I was assessing* my patients.'

Therefore as the analysis of the data from within the narrative thread has widened it has become correspondingly necessary to widen the concept of the primary aims. Put concisely, these new data show that the category of direct nursing care is not synonymous with the primary aims. Instead, the mechanistic nature of Norrie's (1997b) classification has become too limiting, suggesting that the application of this quantitative tool to make meaningful analysis of changes to nursing practice may have to be reassessed.

Taken together these findings allow, as defined on page 147, the generation of an axiomatic hypothesis

'A properly implemented and supported CIS can allow more time for critical nurses to deliver their primary aims of patient care'

This statement has a number of items which should be defined. Firstly, there are a number of conditional elements. The theory suggests that for the relationship to be valid, the CIS must have been well implemented. Phase one identified ways in which CAIT implementation could be optimised. Inspection of the transcripts from phase two suggests that this remains true here, highlighting the importance of focussing on the primary aims of the nurses. This argument therefore enforces the importance of carefully focussing training methods to encompass this. Linda and Edwina also identified that support was an important issue. This was further highlighted by material gained from the literature review, in particular the work of Green et al (1991) and Gilhooly et al (1991) who identified that training and support from a dedicated member of staff are important to promote acceptance of computerised systems.

The next conditional element is the simple word 'can.' In line with their agenda of enhancing the delivery of care, the nurses in both phases described the use of CAIT in terms of promoting their primary aims, in particular of improving quality of nursing care. However this gain is not guaranteed, because other groups will also be involved in any implementation. For example, managerial expectations might mean that any savings in nursing time could equate to managerial changes in working practices, such as employing fewer nurses (Huske & Dalesandro 1986; Barley 1986; Lutheran Hospital 1991). What this implies for the nurses is that if they wish to pursue their agenda, they must become collectively influential in and perhaps lead these implementations. Otherwise it is likely that other agendas will be imposed and the nurses may fail to gain the benefits which they perceive as being valuable. It is believed that the other terms within the theory are fully defined, acknowledging again that the term 'primary aims' has grown to include an element of patient assessment.

As a final addendum to this discussion, the nurses from within this phase discussed their CIS and did not address other aspects of CAIT. However, it may be helpful to the debate surrounding the use of computerised equipment within the clinical setting if the definition can be made more permissive to

include this broader category. Therefore, it can with arguably equal validity be suggested that the hypothesis could be redrafted as follows:

'Properly implemented and supported CAIT can allow more time for critical nurses to deliver their primary aims of patient care.'

It is hoped by doing this that what may be lost in precision in this statement can be gained in its wider applicability, and so it may be useful in moving the debate onwards.

In addition to the main theme, some issues were identified which belonged solely to this research phase and so it remains to be seen whether the research project can give support to them. As with the previous phase, these will be classified as axiomatic memoranda signifying their more tentative nature. Quality of patient recording was identified as an issue. To some extent all the nurses identified these issues, and because they had moved on in their careers, managerial aspects of quality in particular had become relevant. These were exemplified particularly by some of Simon and Linda's comments. Simon in particular identified that the CIS helped him to assess the quality of junior staff recording. His statement about staff *'twiddling their thumbs'* when newly exposed to the CIS, suggests that during this early stage of the implementation period, a number of the issues identified from the literature review may be relevant. What can be suggested is that when time had been saved by the CIS, there was a pause, or window of opportunity, before the nurses accepted the system as being the norm. What is almost identified by Simon (but not quite!) was that this represented an opportunity for restructuring (Barley 1986). The ways in which the re-structuring could be followed may depend on a number of issues. Currie and Brown (1997) suggested that strong personalities may use these opportunities to reshape practice in terms of their own licence, and it could be construed that this is exactly what Simon, operating from a senior nurse viewpoint, did. In addition, the more junior nurses, constrained by their charter had little option but to acquiesce. Fortunately because Simon evidently was also bound by the wish to promote their primary aims, there is no evidence from the interviews that this caused conflict. However, it could be suggested that during this 'window of opportunity' powerful personalities, perhaps augmented by powerful licence, could use the opportunity to impose different agendas. To develop the

example given above, if this was seized upon as an opportunity to employ less nurses, as suggested by Huske & Dalesandro (1986) there would indeed be conflict with the primary aims of the nurses. From this discussion, as defined on page 149, an axiomatic memorandum can be constructed:

'During the implementation of CIS there will be a critical point when nurses re-shape their practice. If this can be done to enhance the achievement of their primary aims, acceptance will be promoted.'

Admittedly, the evidence from the interviews to support this is slim, but it is congruent with material generated in both phases one and two, and from the literature review. The most problematic aspect of the memorandum is whether the critical point exists and whether it can be identified. In effect, this cannot be clarified from this research project because it did not explore the change process of CIS implementation.

Nurse resistance has been widely reported from within the literature (Dowling 1980; Gibson and Rose 1986; Green et al 1991; Timmons and Miller 2002) and this has been tied in with attitudes (Fishbein and Ajzen 1975). There clearly was resistance at Killingbeck as illustrated by both Edwina and Linda, which suggests that the identification of the enhancement of primary aims was not clear to all. For example even within these data it can be seen that Simon described the advantages partly in terms of his managerial licence. Note also that the resistance to the CIS was expressed in terms of the nurses' charter. The data suggest that there was no rebellion or refusal, instead resistance was covert and expressed in terms of rejecting the aspects of the CIS directly related to their work, an effect noted by Timmons and Miller (2002). Therefore another axiomatic memorandum can be identified:

'If CIS do not explicitly support the primary aims of the nurses, resistance will occur, exemplified by rejection of the specific features of the system related to nursing.'

In other words, the nurses will reject the CIS in their own charter terms.

However, there is some evidence also to suggest that this process may be remediable. Edwina gives a personal account of how she rejected, at times, the CIS and both Claire and Linda report on a number of staff who were resistant or unwilling. Edwina does however state that *if* the CIS could save time, (perhaps in an updated version), that is *if* it could give her the

opportunity to promote her primary aims, then she would be willing to *'give it another try but I would look at it first.'* Therefore here at least is one case where the *tabula rasa* could be wiped clean and rewritten upon.

As a final point, within chapter two it was identified that on the whole nurses who had used computers in practice were generally less positive in attitude towards them than those who had not (Brodt and Stronge 1986; Cheatwood and Martin 1988; Bongartz 1988). Within this sample, three out of the four respondents were very positive about the CIS, therefore given the right system in the right place delivering the right results, it *is* possible to produce a system which nurses will view enthusiastically. What remains to be ascertained is whether such systems are currently available and can be successfully implemented.

Conclusion

This phase has added to the definition of the phenomena identified in the first. It has also added new items, in particular the role of CIS in saving time to help the nurses deliver the care which they value to their patients. However, as a research project, what has resulted is neither intellectually nor aesthetically pleasing.

Certainly, some interesting ideas have been generated, but their applicability within the clinical environment has not been tested. In summary, induction has taken place, phenomena have been identified and it has been suggested under which conditions these might operate.

To complete the project a deductive design will next be used to apply the inductive content to the clinical setting. This step potentially has two possible outcomes. Either it will show the work to have been a dead end, of only passing interest, or it will be shown to have application in the real world.

Phase three: Quantitative questionnaires comparing CIS and non CIS sites

Introduction

Thus far, two sets of nurses have been consulted. The first set could be described as 'pre implementation' subjects, who were aware of the possibilities of a CIS. The second set had used a CIS in the past but no longer did so, these were the 'discontinued' subjects. What was missing therefore was a phase of research where nurses who currently used a CIS were investigated. Without this final investigation, the project remains open ended and incomplete. It was decided therefore that the focus for this final phase of the research project was to compare one or more sites which used a CIS with one or more sites which used conventional charting and recording methods.

The study

To do this there were a number of options. Given that attitudes could not readily be identified from a series of binary questions (i.e. 'yes' and 'no'), it was decided to use a Likert scale as the main instrument of the questionnaire. The Likert scale was initially described by the North American social researcher Rensis Likert (1903-1981) in 1932. It presents a series of items which are seen to be either favourable or unfavourable with gradations in-between to the respondents, who are asked to indicate their agreement or disagreement with each item (Selltiz al 1976). The first two phases of research identified which issues related to data management were important for nurses. These findings proved to be amenable to the type of phrasing used in a Likert scale. A further advantage of using a Likert scale can be identified: its pedigree. The Likert scale has been widely used and is a venerable method, it is doubtful if many other research techniques will remain valid after seventy years.

There are however limitations. Firstly, one disadvantage is that often the individual score of a respondent has little meaning, as different patterns of response may lead to the same score (Oppenheim 1992). However, this limitation is not really significant within this piece of research as individual scores

will not be used. Instead advantage will be taken of the survey format and analysis will be by site, not by the individual respondent. Secondly, ordinal data is produced from the Likert scale. As ordinal data there is no arithmetical progression within the responses produced from the questionnaire, therefore it is not as sensitive or flexible as interval or ratio data, but the data *is* still suitable for statistical analysis and so may be used to determine whether the differences between CIS and conventional sites are statistically significant (Oppenheim 1992).

In summary, by administering the Likert scale in clinical areas which use a CIS and comparing the results with those clinical areas which rely upon conventional charting, it was hoped to be able to determine whether the CIS really could make a significant subjective difference to the nurses, and whether it did support their nursing care in comparison with conventional sites.

Methods

The individual items to be included within the Likert scale were derived from the interviews within phases one and two. This was done by returning to the original data of both sets of interviews rather than the coded derivations used in the subsequent analyses. It was felt that because some time had elapsed since the original inspection of the interviews, the quality and granularity of the research would be aided by a new open coding of the data. This resulted in 23 items which were randomly placed within the questionnaire. In line with the suggestion of Black (1999) statements were recast, where necessary, to result in 50% positive and 50% negative phrasing, to minimise bias in response. In addition some further rephrasing was necessary, so that the statements would be relevant in settings with either a CIS or using conventional paper charts. The pilot scale was administered to a group of subjects representative of those with whom the questionnaire was to be used, in this instance a group of ten nurses on the cardiac intensive care unit at Glenfield Hospital, Leicester.

It has been recommended that the responses from this stage should then be scored and analysed to determine which of the items discriminate most clearly between the high scorers and the low scorers on the list (Selltiz al 1976;

Oppenheim 1992) before completion of the final scale. However it was decided to omit these two steps. This was because of the nature of the statements. If the statements had been generated by the researcher *de novo*, this would have been an important step. However, because the statements originated from the interviews in phases one and two, it was felt that the gains from this analytical process would have been outweighed by the possible distortion or unbalancing of the collection of statements, caused by editing them using what would inevitably be a small and potentially unrepresentative pilot sample of respondents.

Although Likert scales traditionally use a five point scale, scales between three and seven points have been advocated (Black 1999; Oppenheim 1992). It was decided to use a four point scale, thereby missing out using a median point such as 'acceptable' or 'uncertain.' Instead, the choices offered were 'strongly agree, agree, disagree and strongly disagree', which it was hoped would encourage the recipients to make positive or negative choices and so produce more emphatic data, avoiding what Oppenheim (1992 p200) describes as a *'lukewarm response.'* In addition to the Likert scale, a small selection of open ended questions were included, to encourage staff to identify the strengths, weaknesses and any other issues related to their methods of data collection which they would care to identify. Following the pilot stage, some minor alterations were made, primarily relating to phrasing.

Participants

At the time of planning the research project, discussion with Agilent, the company which distributed and supported Hewlett Packard's CareVue 9000, revealed that there were only three sites nationally which used this system and which had what might be termed 'mature' implementations of CIS. Maturity was defined as those systems which had been running for at least two years and which therefore had been through the stages of change management. These sites were at the John Radcliffe Hospital in Oxford, the Royal Brompton Hospital and the Great Ormonde Street Hospital, both in London.

Informal discussion with interested senior nurses at these sites suggested that of the three, the John Radcliffe Hospital Oxford implementation might be the

most suitable, as the system administrator was a nurse who had an interest in research and was very willing to take part and act as a clinical co-ordinator. The John Radcliffe intensive care unit employed approximately 114 nurses and had a full capacity of 12 intensive care and six high dependency beds. A number of specialities were catered for within the unit, including trauma, cardiac, renal, general surgery and medicine. This is one of the larger general intensive care units in the country. Within the unit, a system of team nursing was in operation, where nurses worked within specialist teams, and were allocated to patients depending on their clinical speciality, an innovative and flexible system.

CareVue had been established within the unit for over seven years at the time of the research. Broadly, it worked in line with the description provided in the literature review (Duce and Harris 1990). Specifically, at the John Radcliffe, CareVue works by interrogating the patient monitoring system several times per minute. A nurse then validates and hence records and stores the data, typically on an hourly basis. In this way, the majority of patient parameters are directly accessed, including invasive pressures, heart rate, oxygen saturation and respiratory rate. In addition, the system can directly access observations from the patient's ventilator, where one is used. Although the system does not automatically access fluid administration details, it does automatically calculate balances from hand entered input and output data. In addition, the system has a drug prescription facility which is written up by the medical staff, and it can calculate concentrations of drugs for the nurses. The system is linked to the local HIS and can hence acquire results from the various pathology laboratories including microbiology, biochemistry and haematology. Although perhaps not directly of use to the majority of the nurses who use the system at the bedside, the database which records patient information had been recently reconfigured, making it much more accessible as a research tool and for tracing patient records.

This shows clearly that CareVue is a flexible system which is still being developed. Although this site is commonly termed 'paperless', in fact it is not, because the nursing care planning package that accompanies CareVue has not

been used. Instead a paper system was used to conventionally record patient assessment, planning, implementation and evaluation of care.

Access was also gained to two local non computerised sites for comparison. The first and largest site, the critical care unit at Leicester General Hospital (LGH) employed approximately 65 nurses who covered eight intensive care and four high dependency beds. The nurses again operated a system of team nursing, although it was a different arrangement to the John Radcliffe. At LGH, nurses worked in teams of approximately 12 and were responsible for two beds within the unit, in order to promote continuity of patient care. Instead of a CIS, a conventional paper charting system was used: the chart covers a 24 hour period and is replaced each day. In addition other data such as laboratory results are kept on ancillary sheets. There is however a direct computer link to the HIS which prints off individual copies for storage in the patients records. Care planning was based upon a pre-printed plan which was individualised by the bedside nurse.

The final unit included was the general intensive care unit at Glenfield Hospital, Leicester, (referred from here onwards as 'Glenfield'), which again used conventional charting. This was the smallest of the three units involved, employing approximately 35 nurses, to cover five beds. The nurses worked within teams, although the team structure related more to the professional support and development of the nurses, rather than to the way in which patients were allocated and cared for. The majority of patients were referrals from within the hospital, a mix of medical and general, thoracic and cardiac surgical patients. As with the LGH site, a 24 hour chart was used and replaced every day. There was a similar use of ancillary paper work and again care planning was based upon a pre-printed plan, individualised by the bedside nurse.

Sampling

Usually sampling refers to the people who will be investigated to produce explore the research findings. However this is not necessarily the case. Sampling can also relate to other units of analysis such as organisations, schools and local authorities (Bryman and Cramer 1994). In this case, the main sampling units

were the critical care units themselves. Ideally a random sample of units would be used, large enough to include a selection operating CIS. Unfortunately however, implementations within the UK are too few to reasonably allow this to take place. The three sites chosen can best be described as examples of a purposive sample. Bowling (1997 p167-168) defines these as

'deliberately non random samples which aim to sample a group of people or settings with a particular characteristic,'

the characteristic in question being the presence or absence of a CIS. Within the three units, an inclusive sample of nurses was used, i.e. all the nurses were given a questionnaire. In terms of sampling of data this is logical. Perhaps the most common form of sampling is random sampling, where a (large) population is represented by a smaller sample. However in this case, all the nurses within the units were used to avoid the possibility of an unrepresentative sample being chosen, a situation which is not always avoided by random sampling (Bowling 1997). In addition the inclusive sample also helped to maximise the amount of data generated.

Measures

The completed Likert questionnaire is attached in table 18.

The Likert scale questionnaire was highly prescriptive, that is the respondents had no freedom to express their views outside the pre-ordained tick boxes. It was decided that since a large group of nurses within different sites were being accessed, it would be a good opportunity to also give them the option of expressing their own feelings about their charting system, be it computerised or not. To this end, two open ended questions were added to the questionnaire, asking respondents to identify what they felt were the strengths and weaknesses of their recording systems (table 19). By giving the opportunity to express either (or both) negative and positive opinions it was hoped to avoid bias. In addition the nurses were invited to make any other comments which they felt to be relevant.

Table 18: Likert Questionnaire

	Strongly agree	Agree	Disagree	Strongly disagree
Our charting system works well.				
I cannot find information from the charts easily.				
It allows me to easily keep track of all my patients results.				
Our charting of patient data is unreliable.				
The care planning is difficult to use				
Our charting system is poor at finding the information I want about my patient				
The charting system provides a good record of the patient.				
If things happen to my patient I will not be alerted by the charting system.				
The charting system helps in communication within the nursing team				
The charting system compromises patient confidentiality				
The charting system hinders communication within the health care team				
The care planning is not an efficient use of my time				
I feel that the charting does not help me to review my patients progress.				
The care planning helps me look after my patient				
The care planning documentation is repetitious.				
I don't think we keep track of our patients progress well.				
The charting system doesn't make me feel in control of the situation.				
The charting system alerts me to what is happening with my patient.				
I did not need much training to be able to use the charting system.				
The system in use for charting adds to my workload.				
The current charting system helps me to deliver quality care.				
The charting system is always legible.				
The charting system is always accurate				

What clinical grade are you? .....

Table 19 Open ended questions

Do you have any comments to make about the way in which you record patient information?
Strengths of your recording/charting system:
Weaknesses of your recording/charting system:
Other comments:

Procedures

Following negotiations with the senior nursing staff at all three clinical areas and receiving permission from relevant ethical committees, questionnaires were distributed by putting a questionnaire in the pigeon hole of each member of staff with their name on it. A 'post box' was put in the coffee rooms at the three sites to receive completed forms. A month was given to complete and return forms, plus occasional polite reminders from the researcher and from the clinical co-ordinator at the John Radcliffe.

The overall rate of response was 47%. Responses from individual sites are summarised in table 20

Table 20 Rate of response for questionnaires used in phase three

Site	Responses	Total staff	Response rate %
John Radcliffe	38	114	33
LGH	40	65	61
Glenfield	23	35	65
Total	101	214	47

Data from the completed questionnaires were entered on to the data editor of the Statistical Package for the Social Sciences (SPSS: trademark of SPSS Incorporated of Chicago, USA) version 10.0 for Windows.

Analysis of statistical data

Prior to carrying out the statistical testing, a number of steps were required to make the data meaningful. Firstly, as the raw data stood, the Likert scale questions were a mix of both positive and negative statements. These needed to be rearranged, so that the data were 'all pointing in the same direction' i.e. positive responses gave relatively positive numerical values, and negative responses gave relatively negative ones. For simplicity and hence reliability, the data had been entered into the SPSS data editor with the values of 'Strongly agree' corresponding to 1, 'Agree' corresponding to 2, 'Disagree' corresponding to 3 and 'Strongly disagree' corresponding to 4. This was acceptable for the negative statements, but was counterintuitive for the positive ones. The positive statements were therefore jointly identified by the researcher and his supervisor and were inverted using the 'transformation' menu within SPSS so that the positive statements gave an increasing score as agreement increased. Descriptive statistics were generated and are shown in tables 21-43 in appendix four.

Secondly, editing of the items in the questionnaire was required. CareVue has a nursing care planning capability, therefore items were included to cover this within the questionnaire. However, despite showing and discussing the Likert scale with the clinical co-ordinator at John Radcliffe prior to dissemination, it was not identified, until the return of the questionnaires, that the care planning facility had never actually been used, and the system in place was a conventional pre-printed core care plan which was then completed by hand. Therefore the questions relating to care planning did not relate to the test variable i.e. whether or not a CIS was used. Because of this, the four questions relating to care planning were not used in the initial batch of tests to gauge the effect of the CIS. Lastly, from the 19 remaining questions, mean responses were calculated using the 'compute' menu within SPSS, and these values were used for all subsequent statistical tests.

The next step was to identify whether it was safe to summate the questionnaire. One way in which this can be established is by an examination of

internal consistency. Ideally, summated instruments such as a Likert scale are composed of a set of items that all measure the critical attribute and nothing else. Other items not relevant to the topic may however be included, which will tend to decrease internal consistency (Pollit and Hungler 1993; Anthony 1999). In this case the questions were obtained from interviews and it is possible that within these, extraneous issues might have been included. A clear example is the four questions relating to care planning which were indeed removed. If they had been included, they could have been expected to worsen internal consistency, perhaps markedly so.

A number of tests are available to analyse internal consistency. One of the most sophisticated and sensitive is Cronbach's alpha. This produces an estimate of reliability based upon all possible correlations between all the items within the scale. It produces a value or coefficient of reliability between zero (no internal reliability) and one (completely internally reliable). For example, a value of 0.70 would suggest that 70% of the correlation between items within the questionnaire was reliable and 30% could be attributed to other, possibly random factors. The higher the value therefore, the better. There is however some difference between authorities of what constitutes an acceptable alpha. According to Bowling (1997), Cronbach himself suggested that >0.50 was satisfactory, but others such as Anthony (1999) suggest that >0.70 is desirable. The results for an alpha analysis are shown in table 44.

Table 44: Alpha analysis of questionnaire after all items relating to care planning have been removed

Test Statistics	
Number of cases =	91.0
Number of items =	19
Alpha =	0.85

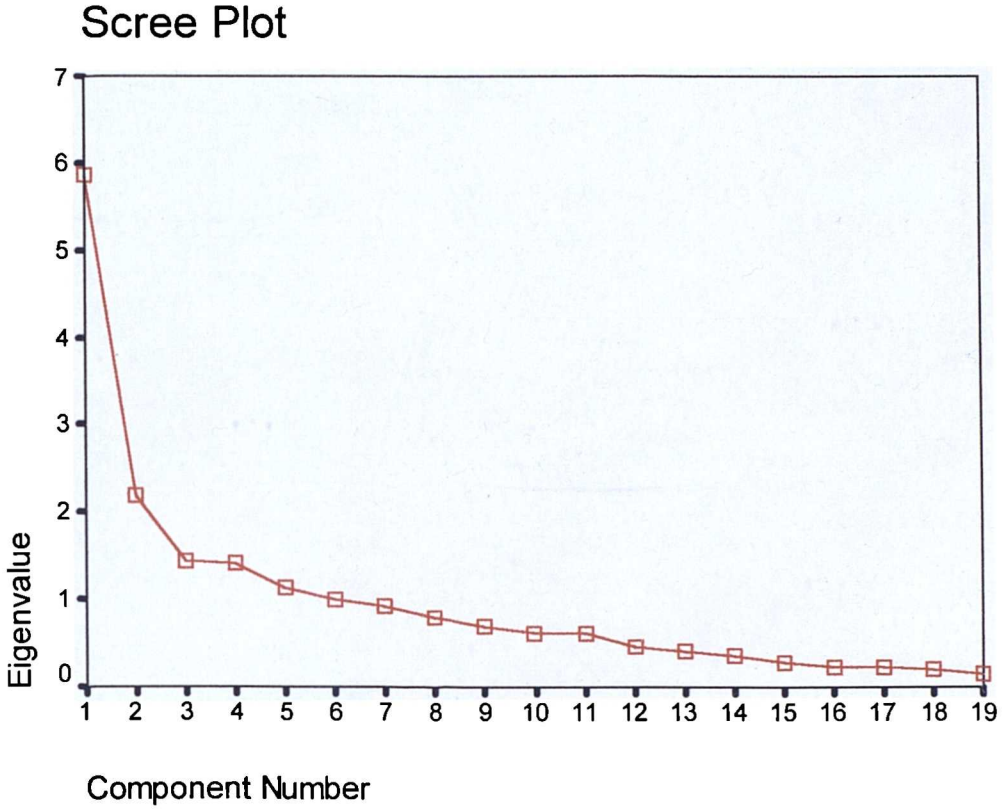
The alpha value of 0.85 shows an excellent level of internal reliability suggesting that the questionnaire looks largely at one issue only. This can be investigated further.

Exploratory factor analysis

Factor analysis was first described by Thurlstone in 1931. It is a statistical technique most commonly used to reduce the number of variables and hence complexity, and to detect some underlying structure in the relationships between variables. Similarly Anthony (1999 p141) suggests that it is a *'method of obtaining meaningful factors'* from a data set. Thus in this instance, the purpose of factor analysis is to identify any distinct groupings from within the 19 variables specified in the Likert scale. It has been stated that for factor analysis the variables should ideally be normally distributed and be based upon interval or ratio data. However this requirement is not absolute and Polit (1996) states that factor analysis of other distributions may be worthwhile. Indeed both Field (2000) and Polit et al (2001) demonstrate that Likert scale measurements, which are based upon ordinal data, can be used successfully for factor analysis. Polit (1996) and Field (2000) also suggest that for factor analysis to take place, sample sizes should include at least 100 individuals to minimise detecting random differences. In fact the data consists of 101. This suggests that this body of data is just within the limits for meaningful analysis. In addition, Polit (1996) states that there should be at least five cases per variable. In this instance five cases per variable gives a figure of 95. Therefore this data satisfies the majority of criteria and can be used for factor analysis with some confidence.

From the data, SPSS initially produces a matrix of sample correlation coefficients which compares correlations of performance on each possible pair of items within the data (Kinnear and Gray 1997). For the process to be useful there must be a number of meaningful correlations present. Polit (1996) suggests that if the matrix consists largely of coefficients with a magnitude less than 0.3 there is probably nothing to factor analyse. In fact, each half of the matrix for the Likert data gives 47 correlations greater than this, once values from the principal diagonal were removed, since these will always have a value of one. From the matrix, groups of correlations are identified as factors. SPSS can produce a scree plot of these factors and this is included as graph 2.

Graph 2 Scree plot showing factor analysis of questionnaire after all items relating to care planning have been removed.



Initially the analysis extracts as many factors as there are variables. Each factor has an eigenvalue, which is a measure of the amount of variance amongst the sample accounted for by that factor. Eigenvalues above one represent variables that account for more than the mean variance. This has been termed Kaiser's criterion (Kaiser 1958). Using this, the scree plot suggests that within the questionnaire, once the questions relating to care planning have been removed, there are arguably six factors which may be meaningful, one of which is much larger than the rest, having an eigenvalue of 5.86.

Another criterion which has been suggested is that the factor should account for a minimum of 5% of the variance within the data. This is illustrated in table 45.

Table 45: Variance related to factor using Principal Component Analysis

Factor	Eigenvalue	% of variance	Cumulative % variance
1	5.85	30.82	30.82
2	2.18	11.49	42.31
3	1.44	7.60	49.91
4	1.40	7.39	57.30
5	1.14	6.01	63.31
6	1.01	5.33	68.64
7	0.92	4.88	73.52
8	0.79	4.17	77.69
9	0.69	3.64	81.33
10	0.61	3.24	84.57
11	0.61	3.20	87.27
12	0.46	2.45	89.72
13	0.41	2.17	91.89
14	0.36	1.89	93.78
15	0.28	1.45	95.23
16	0.24	1.26	96.49
17	0.22	1.17	97.66
18	0.21	1.10	98.76
19	0.14	0.76	99.52

Using this criterion, again the first six factors were selected. What is also notable from the data is that the first six factors account for almost 70% of the variance

within the sample, suggesting that they are representative of the majority of the data set. These therefore will be used for the factor analysis. However it should also be noted that the third, fourth, fifth and sixth factors although achieving these criteria, do have eigenvalues which only just exceed Kaiser's criterion. In addition, each item within a 19 item questionnaire might be expected to contribute to approximately 5% of the variance by chance. Therefore it could be argued that the first two factors are the most interesting within this sample and will be the primary focus in analysis.

The principal components method is widely used in factor extraction. It mathematically takes account of all the variance in the variables. This includes variance due to error. This extraction method is appropriate here because there are a large number of correlations which have magnitude greater than 0.3, i.e. there is a large amount of variance to be distributed within the factors which will not be lost in random error. This therefore minimises the number of assumptions made in the calculations, in comparison to other methods such as principal axis factoring (Field 2000). The first factor (or principal component) is the combination which accounts for the largest amount of variance. The second component uses residual correlations and accounts for the second largest amount of variance. Successive components account for lesser proportions of variance.

Table 46 shows the matrix of the principal component factor analysis. Note that the Likert values of the questionnaire items have already been manipulated in the initial inputting of data so that they should all be read as positive statements.

The table is composed of eigenvectors, often termed factor loadings. According to Anthony (1999), as a convention, factor loadings within the matrix which rise above 0.30 can be considered as being of importance within the factor. However Field (2000) suggests that 0.40 is a more discriminatory threshold, and so this will be used here. Sorting the matrix by size of factor loadings and suppressing the values below 0.40 gives table 47

Those with a positive value show a positive correlation within the factor and those with a negative show a negative relationship. This suggests that the first

factor, with three exceptions, is positively correlated with all the items within the questionnaire. It might therefore be worth considering for further usage of the questionnaire whether removal of these three items would improve internal reliability.

Table 46: Factor matrix using principal component analysis

	Factor					
	1	2	3	4	5	6
Our charting system works well.	.668	-.296	-.084	-.160	-.148	.251
I cannot find information from the charts easily.	.499	-.470	.192	-.213	.044	.229
It allows me to easily keep track of all my patients results.	.598	-.260	-.228	-.174	.176	.290
Our charting of patient data is unreliable.	.522	-.331	.012	.184	-.056	-.484
Our charting system is poor at finding the information I want about my patient	.655	-.367	.064	-.318	.059	-.220
The charting system provides a good record of the patient.	.693	-.255	-.066	-.295	.019	.023
If things happen to my patient I will not be alerted by the charting system.	.244	.492	.456	-.349	-.276	.184
The charting system helps in communication within the nursing team	.615	.494	-.213	-.076	.175	.011
The charting system compromises patient confidentiality	.226	-.010	.270	.526	.493	.458
The charting system hinders communication within the health care team	.616	-.013	.329	-.072	-.278	-.080
I feel that the charting does not help me to review my patients progress.	.700	.048	-.101	-.201	.349	-.144
I don't think we keep track of our patients progress well.	.599	.331	-.103	.046	.072	-.328
The charting system doesn't make me feel in control of the situation.	.418	-.107	.601	.338	-.071	-.089
The charting system alerts me to what is happening with my patient.	.436	.654	.166	-.278	-.057	.167
I did not need much training to be able to use the charting system.	.177	.313	.333	.011	.560	-.295
The system in use for charting adds to my workload.	.505	-.288	.289	.375	-.240	.012
The current charting system helps me to deliver quality care.	.660	.427	-.100	.285	-.156	.110
The charting system is always legible.	.711	-.091	-.387	.278	.068	.115
The charting system is always accurate	.557	.297	-.373	.373	-.341	-.048

Table 47: Factor matrix *using principal component analysis, excluding* values less than 0.40 and sorted by size

	Factor					
	1	2	3	4	5	6
1 The charting system is always legible.	.711					
2 I feel that the charting does not help me to review my patients progress.	.700					
3 The charting system provides a good record of the patient.	.693					
4 Our charting system works well.	.668					
5 The current charting system helps me to deliver quality care.	.660	.427				
6 Our charting system is poor at finding the information I want about my patient	.655					
7 The charting system hinders communication within the health care team	.616					
8 The charting system helps in communication within the nursing team	.615	.494				
9 I don't think we keep track of our patients progress well.	.599					
10 It allows me to easily keep track of all my patients results.	.598					
11 The charting system is always accurate	.557					
12 Our charting of patient data is unreliable.	.522					
13 The system in use for charting adds to my workload.	.505					
14 I cannot find information from the charts easily.	.499	-.470				
15 The charting system alerts me to what is happening with my patient.	.436	.654				
16 If things happen to my patient I will not be alerted by the charting system.		.492	.465			
17 The charting system doesn't make me feel in control of the situation.	.418		.601			
18 The charting system compromises patient confidentiality				.526	.493	.458
19 I did not need much training to be able to use the charting system.					.560	

However it can still be argued that given their sound provenance i.e. being generated from the qualitative phases, issues such as training (factor loading= 0.177) and confidentiality (factor loading= 0.226) remain relevant, even if they contribute more within different factors. Further consideration can be given to the lesser factors to ascertain whether, in addition to this aggregation of the

majority of questionnaire items, other patterns of meaning are present within this data. For example factor two has an eigenvalue of 2.18 and accounts for over 11% of the variance. Can it be characterised?

Factor analysis has been criticised as being subjective, in that although it can identify mathematical concepts which may have meaning (i.e. the factors), these then need to be interpreted and classified (Coolican 1999). Unfortunately factor two is resistant to characterisation. Unsurprisingly two items with directly opposing meanings correlate together (items 15 and 16), since the questions have been reoriented so that positive responses give increasing scores. However, the majority of items within the factor cannot robustly be conceptually related to each other. Instead, they cover three disparate issues: the delivery of care, communication and alerting the nurse to what is happening with their patients. In addition, some aspects of these qualities are also clearly discernible in excluded items, for example communication is included in item seven, and (item 10) 'keeping track of the patient' has similarities with items 14 and 15.

This discussion suggests that perhaps the most important finding from the factor analysis thus far, is that whereas the first factor is most readily characterised as being reflective of the majority of the questionnaire, as yet the nature of the lesser factors remains unclear.

Factor rotation

The factors are vectors. This means that they have both magnitude and direction. Because of this it is possible to position them in different ways, so that, for example they might be oblique or orthogonal, to see whether different clusters of variables can meaningfully be identified. Moreover, once initial factor solutions have been identified, the factors can be rotated in the hope of identifying a more readily interpretable solution. This is most commonly done in SPSS by varimax rotation (Kinnear and Gray 1997). However there are limitations to this which make it less suitable in this instance. Varimax is an orthogonal rotation. This means that the factors in the test are conceptually viewed at right angles to each other and are therefore independent. Given the nature of the questions, which were all derived from the research in phases one and two, this seems to be

unlikely. This is because the nurses are likely to be focussing on issues which do indeed feed into each other, around issues within the clinical environment such as the ways in which data management can support nursing care. It might be better therefore to use an oblique rotation. In oblique rotation the factors are allowed to correlate with each other, which may accord better with the interconnected nature of the data (Howitt and Cramer 1997).

In SPSS, oblique rotation using direct oblimin produces both pattern and structure matrix. The pattern matrix was used for analysis as this has been described as being less susceptible to misleading correlation between factors and is usually simpler to interpret (Field 2000).

The results of the rotated factor analysis of the first six factors using oblique rotation are given in table 48. However, having obtained the rotated factor analysis it is once more not possible to successfully characterise the factors obtained. For example, again excluding the values of less than 0.4 and sorting by size gives table 49. In factor one, the issues do not fall into classifiable groups, instead they include a mix of categories found throughout the questionnaires. Therefore the initial interpretation of factor one based upon an un-rotated factor analysis should stand. Factor two, can be characterised as looking at whether the charting system can alert the nurses to changes in the patient. However, this is not a supra-category at all, as the analysis has instead again identified the correlation between the two directly opposing statements noted earlier. If more information was required on this aspect of the research, it would be simplest to directly explore these items within the initial Likert data. It does however suggest that the Likert scale may be disproportionate in some of its elements and it can be suggested that for further use, removal of directly opposing statements should be considered. No conceptual patterns can be identified from the remaining lesser factors.

In summary, from this factor analysis, it can be concluded that the most readily classified finding remains the initial factor identified in the un-rotated factor analysis, which is representative of the majority of the items within the questionnaire.

Table 48: Obliquely rotated factor matrix

	Factor					
	1	2	3	4	5	6
Our charting system works well.	.715	.091	.095	.146	-.225	.038
I cannot find information from the charts easily.	.739	.050	.205	-.262	-.081	.101
It allows me to easily keep track of all my patients results.	.776	-.046	-.171	.114	-.026	.159
Our charting of patient data is unreliable.	.163	-.363	.485	.198	.224	-.287
Our charting system is poor at finding the information I want about my patient	.682	-.050	.191	-.110	.221	-.277
The charting system provides a good record of the patient.	.734	-.052	.037	.051	.061	-.133
If things happen to my patient I will not be alerted by the charting system.	.007	.855	.128	-.060	-.025	-.068
The charting system helps in communication within the nursing team	.197	.260	-.234	.530	.336	.043
The charting system compromises patient confidentiality	.062	-.080	.209	.050	.187	.868
The charting system hinders communication within the health care team	.250	.321	.484	.106	.003	-.164
I feel that the charting does not help me to review my patients progress.	.528	.005	-.096	.178	.483	.037
I don't think we keep track of our patients progress well.	.003	.062	.077	.495	.414	-.174
The charting system doesn't make me feel in control of the situation.	-.057	.106	.783	-.023	.143	.173
The charting system alerts me to what is happening with my patient.	.074	.733	-.113	.249	.169	-.017
I did not need much training to be able to use the charting system.	-.125	.072	.078	-.127	.787	.148
The system in use for charting adds to my workload.	.123	-.060	.686	.185	-.146	.114
The current charting system helps me to deliver quality care.	-.013	.253	.152	.743	.014	.140
The charting system is always legible.	.409	-.247	.013	.626	-.005	.178
The charting system is always accurate	-.109	-.007	.124	.914	-.157	-.076

Table 49: Obliquely rotated factor matrix, excluding values less than 0.4 and sorted by size

	Factor					
	1	2	3	4	5	6
It allows me to easily keep track of all my patients results.	.776					
I cannot find information from the charts easily.	.739					
The charting system provides a good record of the patient.	.734					
Our charting system works well.	.715					
Our charting system is poor at finding the information I want about my patient	.682					
I feel that the charting does not help me to review my patients progress.	.528				.483	
If things happen to my patient I will not be alerted by the charting system.		.855				
The charting system alerts me to what is happening with my patient.		.733				
The charting system doesn't make me feel in control of the situation.			.783			
The system in use for charting adds to my workload.			.686			
Our charting of patient data is unreliable.			.485			
The charting system hinders communication within the health care team			.484			
The charting system is always accurate				.914		
The current charting system helps me to deliver quality care.				.743		
The charting system is always legible.	.409			.626		
The charting system helps in communication within the nursing team				.530		
I don't think we keep track of our patients progress well.				.495	.414	
I did not need much training to be able to use the charting system.					.787	
The charting system compromises patient confidentiality						.868

What can also be suggested, following on from the discussion of oblique versus orthogonal rotation is that the lesser factors, although conceptually differing from the first, probably also feed into the main issues within the questionnaire.

Certainly it has not been possible to obtain separate identities for them. As such, the Likert scale data can be used as a summated scale with some confidence.

Comparison of populations

Having explored the quality of the data it was then necessary to identify appropriate statistical tests to compare populations. As previously identified, data derived from Likert scales can be characterised as ordinal in nature. This means that the data have an inherent ordering, but it cannot be assumed that there is an equivalence of interval between points on the scale (Anthony 1999). Because of this, it would be wise to be cautious when assuming that the data would follow a normal distribution, even if casual observation would suggest that the more medial points were more commonly chosen. Indeed Anthony (1999) suggests that this is a major source of inappropriate data analysis in, for example, a third of published articles in the Journal of Advanced Nursing Study (often held as an exemplar of rigorous selection and editing amongst the nursing press), where parametric tests which assume a normal distribution were applied to data which could be shown not to have a normal distribution. Similarly Oppenheim (1992) described the desire of researchers to so treat ordinal data as 'dubious' but concedes that it does take place, without necessarily invalidating the analyses.

Bryman and Cramer (1994) identified three qualities that a set of data should have in order for the distribution to be normal and hence suitable for parametric analysis: (1) The level or scale of measurement is of equal interval or ratio scaling, (2) the distribution of the population scores is normal (3) the variances are equal or homogenous. However, the need to meet these requirements has been questioned, and there is evidence that a number of parametric tests may be robust enough to withstand such misappropriation (Bryman and Cramer 1994). The reward for the researcher who identifies that the data approximates to a normal distribution is access to an artillery of powerful parametric statistical tests including analysis of variation techniques, correlation and regression techniques (Oppenheim 1992). Anthony (1999) however suggests that the urge to use parametric rather than non parametric tests may be based simply upon the desire to get a *'positive result rather than a valid one'* (p227). He further suggests

that often there is no advantage to using parametric over non parametric, except that scientists have traditionally been more familiar with parametric testing. This debate could be argued further and remains an area of contention.

Inspection of a graphical depiction of the data (graph three) suggests that the data were not a close approximation to normal. This can be examined further. The Kolmogorov-Smirnov test can be used to investigate the difference between an observed distribution and a specified population distribution, in this case the normal distribution (Pilcher 1990; Kanji 1999). Running this test on the mean values of the Likert data gives the results shown in table 50.

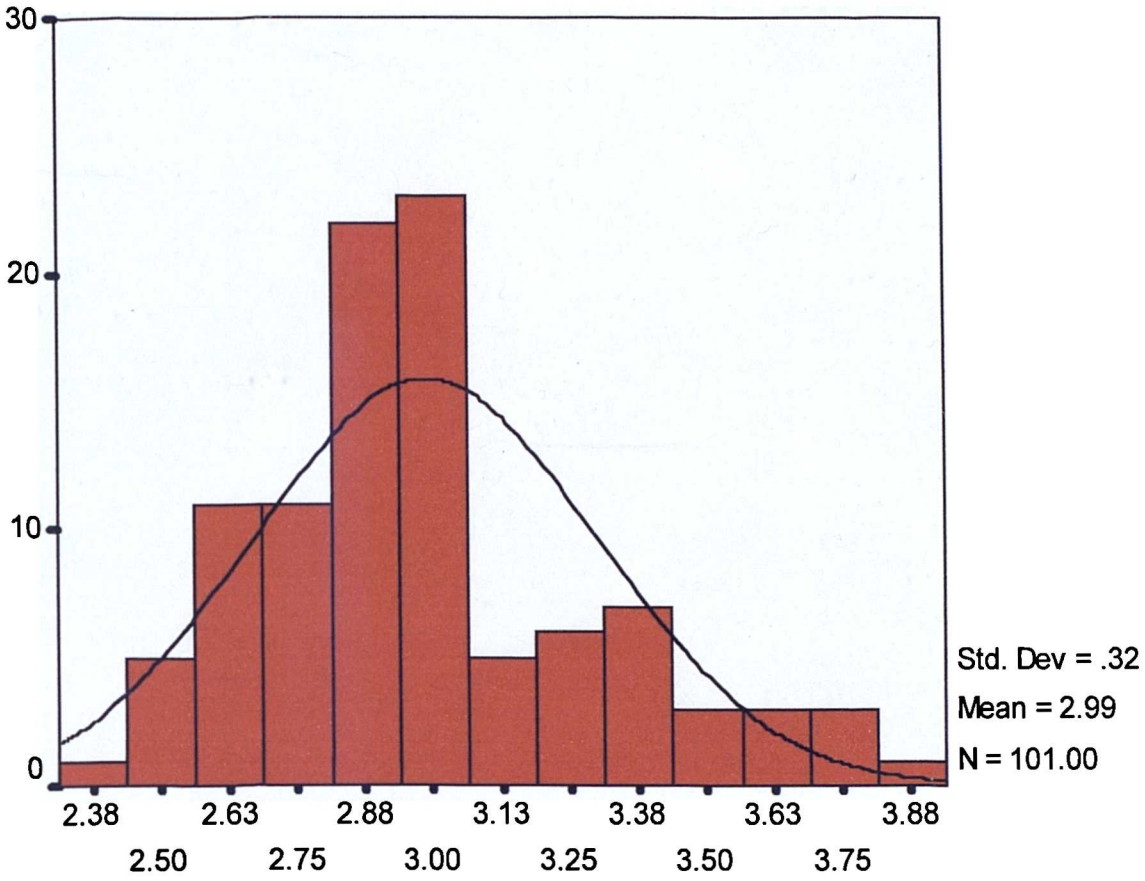
Table 50: One sample Kolmogorov-Smirnov Test. Assessment of the goodness of fit of the data to a normal distribution

		Mean
N		101
Normal parameters	Mean	2.98
	Standard deviation	0.32
Most extreme	Absolute	0.14
Differences	Positive	0.14
	Negative	0.09
Kolmogorov-Smirnov Z		1.38

Test statistics
***p* <0.042**

The *p* value gives the probability of chance alone causing a result to occur. A low *p* value is indicative of a significant result. The threshold at which a *p* value is said to be significant is termed the alpha value. Within the research community the threshold is conventionally set at 0.05 i.e. the result could be explained by chance once in every twenty times. Such values are useful indicators, although they also have limitations (Anthony 1999). There are two main types of error associated with the outcomes of statistical tests. With Type I or alpha error, when using a *p* value of 0.05, every twenty times the test is run a false positive result will occur i.e. an event which does not exist is identified. The logical conclusion from this therefore is to aim for a smaller *p* value such as 0.01 which would suggest that the result could be explained by chance once in one hundred times. Although this would reduce the occurrence of Type I error, unfortunately it would

Graph 3 Histogram of mean scoring with normal distribution overlaid for comparison



also increase the incidence of Type II or beta error. With Type II error, a small *p* value might suggest that results were due to chance, but in fact they were not i.e. an event which *does* exist is not identified Therefore as *p* values get smaller Type I error decreases, but Type II error increases (Knapp 1985; Bland 1995; Anthony 1999). Conventionally a *p* value of 0.05 has been used, because this offers a reasonable compromise between Type I and II errors (Bland 1995; Anthony 1999). However although this is a reasonable guideline, it should not be taken as an absolute demarcation. Bland (1995) suggests that probabilities of around 0.05 provide some evidence of significant differences between samples. The Kolmogorov-Smirnov test shows that there is a significant difference ($p<0.05$) between the Likert data and a normal distribution. Therefore using Bryman and Cramer's (1994) criteria for parametric testing, the data fails on at least two out of three, as they are both ordinal and are not normally distributed. Accordingly, they will be treated as non parametric.

For the analysis of non parametric data from two independent groups, the Mann Whitney (MW) test is appropriate (Bland 1995). Three statisticians, Mann, Whitney and Wilcoxon developed similar tests, known variously as the Mann Whitney U test and the Wilcoxon rank sum test. Although the calculations and samples differ, they measure the same phenomenon. The tests are based upon the rank order of the data and ask whether the sum of the ranks of one sample is sufficiently different from the overall mean of the ranks of both of the groups to indicate that it is not part of a common population. Therefore the statistical test is asking whether the samples are close enough to be considered the same (i.e. no significant difference between samples) or so different as to be considered as two distinct populations (i.e. there is a significant difference between samples) (Black 1999). Differences in application relate to the data. The Wilcoxon works with paired data, and the Mann Whitney test with unpaired data, therefore the Mann Whitney is suitable here because the paired samples used were independent i.e. no nurses at one site were simultaneously working at either of the others.

The MW test calculates a value of *U*: if *U* is less than or equal to a tabulated value based upon the size of the two populations, then the difference between the two can be said to be different (Bland 1995). SPSS automatically computes this to give a *p* value. Unfortunately the MW test for data analysis has one major limitation with regard to this research project. The MW test is bivariate i.e. it compares two series of data, but three sets of data needed to be compared. One solution to this problem would be to run serial MW tests so that all the combinations of site were compared to each other, however this raises a problem which limits the applicability of such multiple pair-wise comparisons.

It has already been suggested that an alpha of 0.05 would be suitable as a basic threshold for significance. This suggests that the result could be explained by chance alone one in twenty times. If this test were then repeated twenty times on data within the sample, then one set of data, despite possessing an alpha of 0.05, could be assumed to be explained by chance alone, and it would be impossible to determine which one (Anthony 1999). The case in hand is less extreme. There are three possible pair-wise combinations of site, but again assuming an alpha of 0.05, this would result in the data being explicable by chance not one time in twenty, but approximately one time in seven, which is probably not acceptable.

Although it is possible to use other tests such as the Kruskal Wallis (KW) one way analysis of variance to explore all three sets of data, this test cannot then identify which population is responsible for a significant result. Therefore it would still be necessary to run *post hoc* MW tests, which would again result in pair-wise comparisons.

To address this, It is intended to run two tests only on the data. The first will compare the responses at the non computerised sites, an important result to examine the reliability of the questionnaire. This data set will then be combined and tested against the data from the computerised site.

A confidence level of 0.05 means that 5% of the time the test is run, a significant result will be found, even with random groups, therefore 95% of the time it will not. As the number of times the test is run increases, Bonferroni

showed that the 0.95 probability is eroded as the number of tests rises (Bland 1995). Where two tests are run, this gives an alpha value, not of 0.05, but instead of 0.097 which would render a type 1 error more likely. Although it is possible to counteract this by using the Bonferroni correction to specify a more stringent alpha value (in this case 0.02), this would then increase the likelihood of producing a type II error (figures computed form online software at Simple Interactive Statistical Analysis 2003). Indeed it has been suggested that using Bonferroni's correction produces more problems than it solves (Perneger 1998). For this reason and because only two pair-wise combinations are intended, the Bonferroni correction will not be employed.

Statistical data

At this point it might be wise to reconsider the nature of the data to be analysed and to define exactly what the questionnaire was measuring. The Likert scale was constructed from the reported hopes and concerns of a number of nurses. The more positive the nurses felt towards their system of data collection and display therefore (whether computerised or not), the higher would be the mean scores taken from the questionnaires. What the questionnaires are therefore identifying are levels of satisfaction with the data collection and display systems in use in the three clinical areas.

Graph four shows a box plot representation of the means from the data. This clearly suggests that the data from the John Radcliffe site had a higher range of scores than Glenfield and LGH, the non computerised sites. The mean values in particular are higher and in terms of the spread of results, there is very little overlap between the computerised site versus non computerised sites. Table 51 shows that there is no significant difference between the two computerised sites (p=0.60).

This is an interesting result for two reasons. Firstly, the fact that both sites cannot be distinguished statistically suggests that the questionnaire may have validity. Certainly if a significant difference had been identified, then factors other than ways of data management and recording would have to be considered to explain the result.

Graph 4 Box-plot showing distribution of mean scores which relate to CIS activities by site

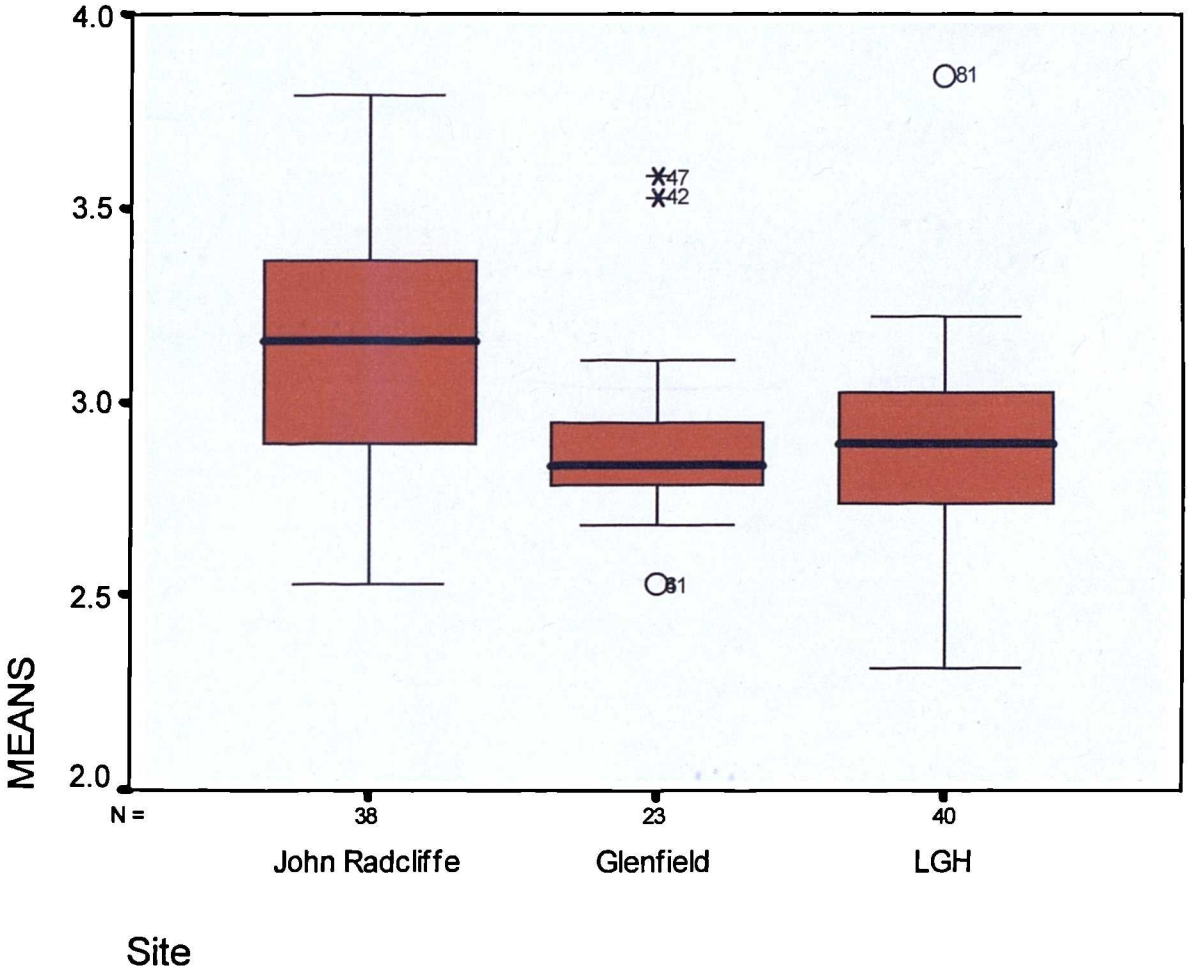


Table 51: Mann Whitney test. Comparing mean scores of data relevant to charting methods at Glenfield and LGH

	Site	N	Mean rank	Sum of ranks
Means:	**Glenfield**	23	30.41	699.5
	LGH	40	32.91	1316.5
	Total	63		

Test statistics
Mann Whitney *U*= 423.50
***p*=0.60**

The two sets of data from the non computerised sites were then combined and compared with the data from the computerised site and tested using MW (table 52)

Table 52: Mann Whitney test. Comparing mean scores of data relevant to charting methods from computerised and non computerised sites.

	Site	N	Mean rank	Sum of ranks
Means:	**Computerised (John Radcliffe)**	38	66.58	2530.00
	Non computerised (LGH and Glenfield)	63	41.60	2621.00
	Total	101		

Test statistics
Mann Whitney *U*= 605.00
***p*< 0.001**

A *p* value of less than 0.001 clearly shows that there are two distinct populations, of which the John Radcliffe gives a higher mean rank score, showing that the nurses are significantly more satisfied with their computerised charting system than at the manual sites.

An interesting point is hidden within the data from the two non computerised sites. If the original data values are considered (1= strongly disagree, 2=

disagree, 3= agree, 4= strongly agree) then any value above 2.5 corresponds to a relatively positive evaluation of the charting system. Using the table of mean values (table 53) it can be seen that although the John Radcliffe gives the highest mean values overall (3.15), at both LGH and Glenfield, the values are still relatively positive (2.87 and 2.89 respectively).

Table 53: Mean scores of all data relating to charting and data management

Site	N	Mean scores
John Radcliffe	38	3.15
Glenfield	23	2.89
LGH	40	2.87

This suggests that on average both the manual and computerised systems of data collection and display are rated as at least satisfactory by the nurses who use them, however the computerised system is effectively more satisfactory.

Other data

The data relating to clinical grade and years of experience are shown in tables 54 and 55 in appendix four.

It was decided to explore these results to investigate whether there was any relationship between either clinical grade, or years of experience and mean scores relevant to the charting methods. To do this a statistical test which identifies correlation between sets of data was required. Spearman's rank test (or *rho*) is most commonly identified as being suitable for non parametric ordinal data (Bland 1995; Anthony 1999; Black 1999). The test produces a coefficient of correlation and a significance value. The coefficient of correlation describes the nature of any link between the two sets of data. If it could be identified that as grade or experience increased there was an increase in mean score, this would be an example of a positive correlation. A coefficient of one would show a perfect arithmetical correlation between two sets. A coefficient of zero would show there was no relationship at all between variables. A negative value would suggest an

inverse relationship between variables, where one increased as the other decreased. A perfect inverse relationship would therefore give a value of negative one.

The results for using Spearman's rank test are shown in tables 56 and 57 .

Table 56: Spearman rank test showing correlation between clinical grade and mean scores of data relevant to charting methods

Test statistics
N= 97
Correlation = 0.130
***p*= 0.204**

Table 57: Spearman rank test showing correlation between years experience and mean scores of data relevant to charting methods

Test statistics
N= 96
Correlation = 0.160
***p*= 0.125**

As a convention, it is reported that a coefficient between 0.10 and 0.30 is described as weak, between 0.30 and 0.50 is medium and above 0.50 is large (Buchner et al 2001). Both these test applications therefore identify weak correlation, but neither proves to be statistically significant. This means that no significant link between clinical grade (p = 0.204) or years experience (p = 0.125) and mean scores could be established. To be rigorous, consideration should also be given to the possibility of error. Clearly a Type I error is not possible here, but a Type II error is: a correlation might have been present but found not be significant, when it actually *was* significant. Some more information can be gained by using a power analysis. Because SPSS does not include power analysis it was necessary to download G* Power software from the internet to examine the power of the test (Buchner et al 2001).

A power value of 0.8 is held by convention to be the norm. This means that the probability of obtaining a Type II error is 0.2 i.e. one in five. Anthony (1999) suggests that this is a reasonable level. The difficulty in achieving a higher power

value and hence a lower possibility of type II error would be excessive sample sizes which may make studies unfeasible.

The result from the power analysis for correlation tests are shown in graph five. This shows that for a sample size of approximately 100 (as present) and an alpha value of 0.05, a power threshold of 0.8 would suggest that effects of approximately 0.27 and larger would probably be identified. This means that although this use of Spearman's rank test might miss small correlation coefficients, it probably would not miss medium or larger effects at all. Therefore the non correlation should be allowed to stand, despite the possibility of a weak correlation having been missed.

This discussion suggests that whether the nurses valued their charting systems highly or otherwise was related to neither grading nor experience within the clinical area. This may be considered as giving some evidence to support the research tool. As discussed previously one possible weaknesses in this design is the amount of uncontrolled variables inevitably involved. In effect this analysis of correlation rules out these two variables as being responsible for any differences between sites.

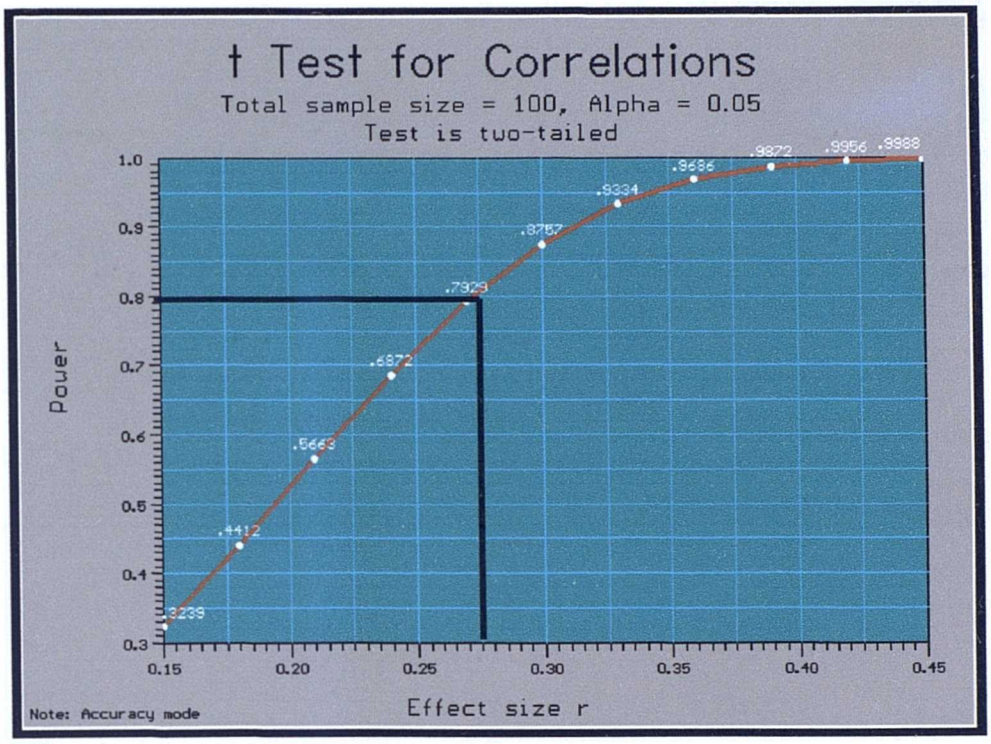
Statistical tests relating to care planning data

As identified earlier, four questions were taken out of the data for the above calculations because they related to care planning, which was a manual process at all three sites. The mean values of the questions relating to care planning are shown in table 58 and are illustrated with their distributions in graph six.

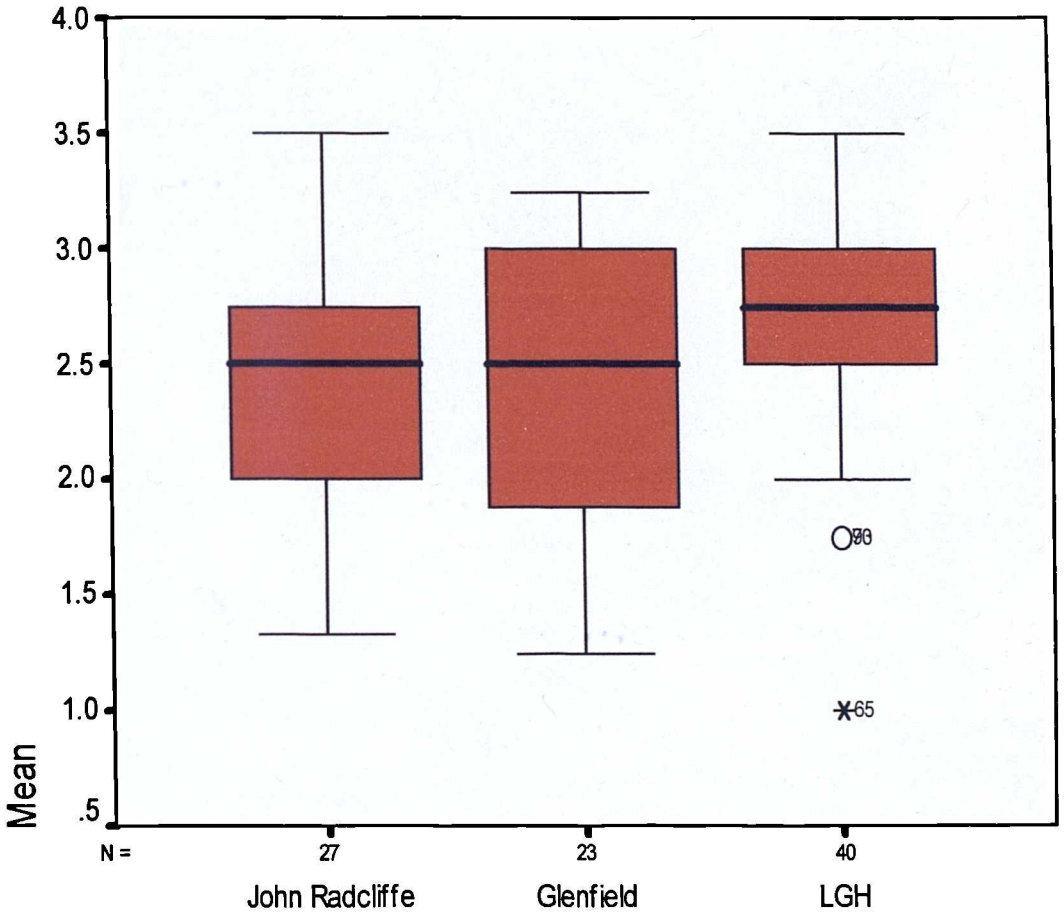
Table 58: Mean scores of all data relating to care planning

Site	N	Means
John Radcliffe	38	2.47
Glenfield	23	2.37
LGH	40	2.67

Graph 5 Power analysis for correlation of data: sample size = 100, alpha= 0.05



Graph 6 Box plot showing distribution of mean scores of Likert scale statements which relate to care planning by site



It was previously suggested that mean responses above the median value of 2.5 were indicative of some measure of satisfaction and those below 2.5 of some level of dissatisfaction. Using this admittedly rather arbitrary measure, at both the John Radcliffe and Glenfield the care planning documentation was rated as just below satisfactory, whereas the care planning at the LGH was identified as just above satisfactory. However, a KW test on this data (table 59) cannot show any significant differences between these populations (p equal to 0.065), therefore this distinction is probably not valid.

Table 59: Kruskal- Wallis Test. Comparing mean scores of data relevant to care planning at all three sites

	Site	N	Mean Rank	Mean scores
Means:	**John Radcliffe**	27	41.24	2.47
	Glenfield	23	38.33	2.37
	LGH	40	52.50	2.67
	Total	90		

***p*= 0.065**

However, using a Wilcoxon signed ranks test (because these results are paired) on the mean of scores at all three sites for data relating to data collection and display, with mean scores relating to care planning, shows that the care planning evaluated significantly less well (p=<0.001)(table 60).

This shows that on the whole, the nurses at all three sites found their care planning paperwork to be less satisfactory than other aspects of their data recording and display, whether computerised or not.

Although of some value in itself, this is an important result in terms of the validity of the data. The variable which it was hoped to explore by using the Likert scale was whether or not a CIS made a difference to nurse satisfaction. The results clearly suggest that it did.

Table 60: Wilcoxon signed ranks test. Comparing mean scores of data relating to data collection and display with mean scores of data relating to care planning across all three sites

	N	Mean rank	Sum of ranks
Negative ranks	18[a]	29.42	529.50
Positive ranks	70[b]	48.38	3386.50
Ties	2[c]		
Total			
Mean: data collection and display			2.98
Mean: care planning			2.54

a: data collection and display <care plan
b: data collection and display >care plan
c: data collection and display =care plan
Test statistics
$p<0.001$

However numerous other variables could influence this result. For example the nurses at John Radcliffe could be paid more or have better working conditions than at the other sites, which could result in higher general levels of satisfaction biasing their responses. Despite this, the data relating to care planning show that the Likert scale is robust enough to withstand the extraneous variables at the three sites, because the differences in the items which related to the care planning, which was essentially similar in principle at all three sites, fell within a similar population of replies. This supports the claim that the Likert scale is a valid tool and although the four questions relating to care planning were actually included in error, this was a very serendipitous error for the project.

This analysis of data therefore has produced two main results, one intentional and one unintentional. The intentional set is that of comparison of data management at the CIS site with the non CIS sites, which shows that the CIS site was rated as significantly more satisfactory than the non CIS sites. The unintentional set of results relates to the care planning, which was identified as being similar at all three sites, supporting validity of the questionnaire.

There is one final set of responses to consider which may contribute further to the discussion of the validity of the questionnaire, the open ended questions which concluded the questionnaire.

Analysis of open ended question responses

The responses were substantial, of a total of 101 questionnaires completed, 65 responded to the open ended items, a response rate of 64%. A transcription of these responses is given in appendix five.

The responses were analysed and coded using the methods identified in phases one and two for the analysis of interview scripts, firstly open and then axial coding of the data were employed. Two points are relevant to the data. Firstly a number of items were recorded under the heading 'any other comments', which fitted more naturally within the other two headings 'strengths' and 'weaknesses.' These were accordingly included within these sections for the report which follows. Secondly, although techniques of textual analysis described in phase one were used, the nature of the text itself was quite different from the text obtained from interviews. The items themselves were short and many had the nature of 'bullet points.' There is correspondingly little flow between or within the statements, and no expansion upon or development of ideas. This rather disjointed nature of the data is also reflected within the report which follows. The categorisation which is developed is useful, it is believed, in that it orders and groups the data, but realistically the analysis remains descriptive rather than analytical: what Glaser (1992) describes as a *'full conceptual description'* (p122).

Reliability for this section was addressed by asking an academic colleague to independently analyse the main themes which emerged. Consultation was then held and some minor changes were made to accommodate these comments.

Open ended items: The findings

Strengths of your recording/ charting system

A total of 29 respondents from the John Radcliffe Hospital (John Radcliffe), 14 respondents from Glenfield Hospital (Glenfield) and 19 respondents from Leicester General Hospital (LGH) identified strengths. Clearly this is not a quantitative study and these do not represent reliable statistics, but this does suggest as a first position, that the nurses at the John Radcliffe could identify more positive qualities than their counterparts at the two non CIS sites (see table 62).

Table 62: Respondents to item 'strengths of your recording/charting system'

Site	Numbers of respondents	% at site
John Radcliffe	29	76
Glenfield	14	60
LGH	19	47

From such qualitative data it is unwise to suggest that this makes the nurses at the John Radcliffe more favourable to the CIS. However, one feature of the data from this site, not found amongst the others, was a number of spontaneous pieces of praise for the system such *as 'I enjoy using CareVue, it is fantastic', 'CareVue is great', 'really like CareVue, hate the thought of going back to charts'* and *'definitely miss using CareVue when working in other areas.'*

This warmth of feeling was not really evident at the other sites. The only corresponding comment to come from the non CareVue site is the somewhat pallid *'the best I have used'*, which was reported by one member of staff at LGH. CareVue does then seem to be able to produce an emphatically positive response in at least a proportion of staff.

The axial coding of the data will be used to explore the statements relating to strengths and will be used as the headings in the report which follows.

Quality

A number of comments were given which related to 'adjectival' qualities of the systems, whether computerised or not, that is they could be described as *'quicker', 'more accurate' 'more legible'* or *'easier to interpret'* and this forms the first theme to emerge.

At the John Radcliffe a large number of respondents identified these benefits. There were nine reports that CareVue was a quick system for recording information and nine reports that it was highly accurate. Some quotes contained a combination of positive elements, for example it was *'quick and accurate, easy to monitor changes.'* Six reports identified that it was more legible than hand completed charts and another six that it was easier to identify recordings such as

blood pressures and heart rate form the data display. These positive attributes were spread widely amongst the responses.

In addition a further six nurses identified that CareVue was able to have all the patient data readily available in one place. One nurse reported that data were

'easily accessible, you don't have to look through the notes because it can be easily seen on CareVue.'

A limitation to the praise was however noted. A number of the responses had qualifying statements attached, 'it's clear, legible, *as long as* people record things accurately it is very reliable' (not original italics). This gives a signpost to one of the limitations of both computerised and non computerised systems, which will be discussed later in greater detail.

CareVue was also described as being easy to use (three reports) and of providing data easily for review of the patient.

Comparison with the other sites shows that at Glenfield, some similar comments were made. Data recording was described as being clear: *'trends were clearly available at a glance'*, *'easy to use'* and *'information i.e. observations readily available and spaced out well'* and *'all the data was readily available for nursing and medical staff'* (a total of seven reports).

This picture was repeated at LGH, where a similar range of strengths were related to clarity, accessibility, and ease of use: *'observation charts make changes in patients condition easily visible'*, *'big chart, easy to read'* and *'very clear and easy to find information'* are amongst the responses. In addition, the charts were seen to be flexible, they

'allow flexibility in observations, can record adverse effects. You can write prompts on the chart for later in the day.'

These positive comments seem almost unanimously to refer to the large 24 hour chart used to record patient observations, determined by items identified i.e. *'observations'*, *'observations chart'* and *'visually accessible to other disciplines.'* This therefore represents a difference between the focus of the comments. At John Radcliffe, the positive comments refer to a broader range of items including patient observations, laboratory results and other sources of data, whereas at

Glenfield and LGH, the non computerised sites, it is narrower i.e. that which is contained within the observation chart itself. However, although this is an observable trend, it is not universal. For example *'arterial blood gases and blood results on separate sheets allows picture to build up'* was reported This is however the only report to positively appraise the ancillary paperwork.

Specific features

The second theme which emerged identified specific features of the charting and recording systems, that is specific items or functions which the staff felt were positive features of the way data were recorded. Quantitatively, the John Radcliffe site reported many more of these than the other non computerised sites, 16 different items were recorded at John Radcliffe compared to an aggregate of six from the other two. However this may be because CareVue actually *has* a large number of features rather than because they are especially helpful or supportive to the nurses. The nurses at John Radcliffe also identified positive ways in which CareVue handled the large amount of data generated in the clinical area. This included the transfer of data from laboratories directly to the bedside, the ability to immediately obtain data on readmitted patients, and the feeling that *'complete data can be assured.'* This was also reported when it came to discharging patients, a notoriously lengthy process in terms of paperwork:

> *'(you) can retrieve patient history easily, especially consolidating all files from admission to discharge....(this is) very important in discharge.'*

Two senior nurses (G grade) also identified it as a useful system for monitoring standards of care within the unit, because CareVue could review two or more sets of data at a time. In addition one nurse specifically identified that *'we definitely chart more information than we used to.'*

In addition to this flow of data management, a number of more applied advantages were identified. Five nurses reported that continuous recording allowed them to concentrate on patient care rather than recording during crises, and no matter what was taking place, CareVue kept a record of ongoing events. Similarly it was felt that it was easy to get information concerning specific incidents from CareVue. However, the same caveat was identified as before, by

four nurses: '*as long as*' people use it correctly it will be reliable and accurate, suggesting that this was not always the case.

Corresponding items were also found at the non computerised sites. Because they used very similar charts, and because there was a large overlap in the comments made, the two sets of data from Glenfield and LGH will be amalgamated. Firstly the layout and physical availability of the charts was identified as being useful. Three nurses highlighted that the charts were *'readily available for nursing and medical staff.'* One of the benefits of a two foot by three foot piece of paper is that it is large e.g. *'visually accessible'* and can be written on, wherever the nurse feels is relevant. Seven nurses identified this flexibility and the ability to add free comments and prompts as being valuable. Similarly, in comparison to the large amounts of data that CareVue could amass, it was identified that the nurse at the bedside was a useful editor of data so that only relevant information was charted, i.e. there was a cognitive step in data recording. This would mean that spurious information due to artefact could be rejected at the discretion of the nurse.

In addition a number of specific features were identified as useful. At Glenfield, the recording of arterial blood gases next to respiratory observations was identified by two nurses as being beneficial and at LGH the spaces for charting drug infusions and boluses were positively identified.

It would seem therefore that both systems, computerised and non computerised, had a number of strengths. Numerically these were greater at the computerised site, which seems appropriate as it is a more sophisticated manager of data than the conventional paper chart. What is less certain is whether this has a beneficial effect upon nursing practices or the patient.

Direct help in patient care

The final theme to emerge from the section dealing with the strengths of the recording systems relates to how the systems directly impacted upon patient care. This link was less evident, because although data management is important to inform the nurses of their patient's wellbeing and needs, neither of the systems then go on to directly affect patient care. In other words there is an

indirect, not a direct effect upon patient care. However, although smaller in terms of numbers of responses some important issues were identified. At John Radcliffe four nurses stated that CareVue allowed them more time to care for their patients, it *'leaves more time to focus on the practical aspects of patient care'*, in addition it was identified that the system allowed the nurse to *'easily identify changes in the patient's condition.'* Both of these are very positive statements, indeed it could be argued of all that has gone before, these are the most applied and hence the most relevant to nursing care.

In contrast, at the non computerised sites, although three nurses at Glenfield and six at LGH identified that their charts allowed easy recognition of changes in the patient's condition, no comments were made about time management, at least not identifying it as a strength.

So far, the positive attitudes of the various charting systems have been identified. The negative will now be explored.

Weaknesses

Four themes emerged from the data. The John Radcliffe data have formed the initial focus of the analysis so far and this pattern will be retained to help consistency in interpretation. The first theme that was identified was that of training.

Training

CareVue is a highly complex piece of computer technology, especially when compared to the traditional critical care chart and so it would be surprising if no mention were made of training issues from the John Radcliffe. However, reports of problems in learning or not being able to use the system effectively were surprisingly few in number, and could be interpreted as being notable for their absence. Indeed only one mention is directly made of training: it *'takes a while to get to use it and then you love it!'*, which suggests that the nurse who wrote this felt that the effort in learning to use it was well worth while.

As might be predicted, training was not seen as an issue at the other non computerised sites, suggesting that the traditional chart was at least as easy to learn to use as CareVue. There is however one final strand of evidence to

suggest that CareVue is seen as being a very useful system by the nurses who use it, and this will be discussed under the heading of the next theme which emerged.

Issues relating to care planning

As outlined earlier, although CareVue has a care planning facility it had never been used at John Radcliffe and so the data relating to care planning could not directly relate to the difference between computerised and non computerised sites. However these data were found to be surprisingly interesting and useful in the statistical analysis and this is also true here. From a cursory glance at the comments made regarding care planning, it was clear that a proportion of staff at all three sites were unsatisfied with the care planning they used. At Glenfield it was described as repetitious, time consuming and requiring a lot of paperwork (three reports). In addition no long term care planning was available which would *'save nursing time and resources better than a new one every day.'* At LGH, another three nurses made very similar comments. At John Radcliffe a number of nurses made similar comments too, but most significantly, no fewer than 13 nurses stated that they wished care planning was undertaken using CareVue. Therefore although there was no evidence to suggest that at any site care planning was better or worse in the nurses' estimation, because such a large group of nurses wished it had been included on CareVue, this strongly suggests that they believed that computerisation of this process would result in a form of documentation that was more satisfactory than a conventional written one. In effect this represents a very positive statement about the general principles of using a CIS and of CareVue in particular, supporting the generally positive estimation of it thus far.

Weaknesses of the system

No system however is perfect, and a number of items were identified with CareVue that the nurses felt were less satisfactory. Two nurses mentioned that they felt confidentiality was an issue, because patients could be viewed remotely at other bed stations. Two were concerned that the system might crash. It was pointed out that not all information such as lab results and fluid administration

devices were automatically accessed and this limited the effectiveness of the system. A number of nurses felt that the printouts from the system were not clear and this could be a hindrance when it came to transferring patients to ward areas. As one nurse stated:

> *'I find the printouts of the observations/ labs etc. quite confusing which must make the ward nurses extremely confused..... I have found myself on many occasions spending longer on the wards explaining where to find information on the chart than actually handing over the patient.'*

Amongst specific features, two nurses felt that the drug prescription feature was not *'user friendly'* and it was reported that only one person could use CareVue at a bedside at a time. These appear to be fairly minor weaknesses though. At the non computerised sites a similar quantity but different spectrum of comments were identified.

At Glenfield, too much repetitive paperwork was identified and the recording of observations and laboratory results was felt to be too time consuming. As a manual system it was identified that if the nurse was too busy, charting would not take place on the hour but would have to be completed retrospectively, increasing the likelihood of errors. At LGH complaints were made again of repetitious documentation which was time consuming and resulted in too much paperwork. It wasn't always accurate, it

> *'doesn't always reflect fluctuations in observations between hourly observations.'*

Finally at LGH some specific weaknesses in the documentation were identified, relating to recording of nursing duties such as mouth care, line insertion, and room for laboratory results.

Comparing the reports from the computerised with non computerised sites, the main issues at Glenfield and LGH were of too much repetitive paperwork. At the CareVue site, no mention at all were made of this or similar concerns. Therefore this does suggest that CareVue has gone some way to solving the problem of nurses wasting time in redundant clerical duties. One final theme did

emerge however, which might place limitations upon the effectiveness of all three systems, but especially of CareVue.

'Only as good as'

This theme has been mentioned already. It described the way in which staff used the CIS and to a lesser extent the paper documentation. Put simply, the CIS was universally acknowledged as having many desirable features. However the extent to which these were used was determined by either the skills or knowledge or attitudes of the nurses who used it. The phrase which summed this interaction up was *'only as good as'* the nurse who uses it. This phrase or one closely resembling it was used by six nurses at John Radcliffe, for example *'it is only as good as the person inputting data'*, *' the charting system is as good as the user.'* The example which was repeatedly used (by seven nurses) to show this was the use of default settings on CareVue.

In order to make a recording, the CIS suggests a reading (the default) which is then either verified by the nurses or rejected and changed. The temptation is to always select the default, since this is the quickest and hence the easiest option. As one nurse put it *'*

'to accept defaults is always a tempting option and sometimes leads to charting errors.'

Other related examples were given. For example it was suggested that data were sometimes entered which were not always true and it was also suggested that too much reliance was made on CareVue at the expense of nursing skills, the example given related to the calculation of drug dosages.

The phenomenon of *'only as good as'* was also found at the other sites, therefore it is not unique to the use of a CIS. At Glenfield, two nurses and at LGH five nurses identified that their charts were sensitive to the *'only as good as'* phenomenon.

This is not a theoretical issue. The language used suggests that these were actual events relevant to patient care. At John Radcliffe one nurse wrote;

'changes (were) not recorded as it defaults to the last hours observation or ridiculous blood pressure readings',

at Glenfield one nurse wrote:

'(the) quality of the documentation depends on the nurses'

and at LGH one nurse wrote:

'depends on the person filling it in as to how comprehensive it is.'

What this suggests is that at all three sites, basically reliable systems of data recording were in place, but the accuracy of the recording was limited by the nurses who used them. The large proportion of responses at John Radcliffe seemed to identify this phenomenon more closely and specifically with the CIS rather than the paper charting at the other sites, suggesting that the more sophisticated system was more susceptible to the effect than its conventional counterpart. This may therefore represent one limitation to the successful implementation of CIS, which would need to be addressed to make the most of systems which are prided on producing large amounts of high quality data. This claim would be devalued if a significant proportion of the data were found to be inaccurate.

Other comments

The final open ended statement invited the nurses to put forward any other points which they wished to make. In support of CareVue, eight nurses finished by making what were effectively unsolicited positive statements about their system, this was not noted at all at the conventional sites. This effect has already been discussed and was the only substantial theme which emerged from this section of the questionnaire.

The points which remained, after comments reporting strengths or weaknesses had been relocated, referred to disparate issues which the nurses felt were pertinent. At John Radcliffe one nurse felt that her typing skills limited her use of the system, surprisingly perhaps there were no further reports of this, suggesting that the inputting of data was felt to be straightforward. At Glenfield the time at which the 24 hour chart was started was queried. As a conclusion, perhaps the final word in this descriptive analysis should be given to a nurse at LGH: *'I would welcome a computerised system!'*

Synthesis of phase three findings

The material from the open ended questions will be considered before that of the Likert scale. This is because of the nature of the data. One of the overarching aims of the research was to move from induction to deduction. In effect, the quantitative phase of the research was designed as the forum where much of the data from the previous qualitative research would be tested in the field, essentially to see if they 'worked' in a real life setting. By contrast, the responses from the open ended questions are much more closely related to the inductive material of phases one and two. Thus although this third phase of research was intended to only affirm or disaffirm the theory which had previously been produced, unexpectedly it also helped generate new findings, which will be discussed first.

The most striking theme to emerge from the descriptive analysis of the responses was the spontaneous praise of the CIS at John Radcliffe. Nothing similar was found at the non CIS sites. This therefore suggests that under favourable conditions a CIS can indeed be viewed favourably by critical care nurses. This is congruent with the theory generated from phases one and two . However, a number of contextual criteria still have to be met if this finding can hold. Specifically, in order to operate as axiomatic theory, two criteria should ideally be clarified: the conditions necessary for this approbation, and what the nurses gained from using the CIS. Unfortunately there was little information given concerning the operational conditions within the responses. A number of authors such as Plummer and Warnock-Matheron (1987) and Green et al (1991) have identified training as being important for successful implementation, but this has never really been explored through research. Indeed it was identified that reports of inadequate training or poor preparation prior to using the CIS were conspicuous by their absence, but this was also true of good training and preparation. At the John Radcliffe training was informal, staff being supported by a mentor during their first weeks on the unit. Therefore it could be described as experiential in nature. This suggests that this is one strategy which can be successful in CIS implementation. However it is plain that some further

descriptive research would be useful, to use as a benchmark, or point of departure for other implementations: whatever they do at the John Radcliffe in terms of support and implementation, they seem to do it well!

This leaves the second component to be addressed: operationally, what the nurses gained by using the CIS. It has been identified that a number of the positive qualities were adjectival, or incremental in nature, i.e. the CIS could be 'quicker', 'more accurate', or 'more legible.' On closer inspection these appear to specifically refer to aspects of patient data management. This was also reported in the section dealing with specific features of the system, where the comments centred around aspects of data management such as patient transfers and the accessing of good quality data regardless of the patient's condition. Thus a theme which was also identified within the first two phases but not really developed, has become emergent in this the third. This allows, using the definition on page 147, the identification of a novel axiomatic hypothesis:

'a properly implemented CIS will be useful to nurses because it manages the large amount of patient data generated in critical care'

This statement approaches the conditions of axiomatic theory, in that it contains a truth, in this case the relationship between the CIS and patient data, and the conditions under which it operates. However, the use of 'properly' is a weakness, as it is too permissive. This is therefore a limitation to the quality of the theory generated by this phase of the research.

This is the first main theme to move away from the concept of the nurses using their own language to explicitly identify their nursing primary aims. It suggests that what the nurses wanted or could achieve might in fact be less simple than the syntheses have so far suggested, and in fact the nurses aims might be more than unidimensional as suggested by Trochim (2000). In phases one and two, it was suggested that successful implementation may be dependant on using the nurses' own language to show how a CIS could help them achieve their primary aims. However, although this may still be valuable, this third phase has suggested that this is not the only issue of importance to the nurses and a

more technical discussion of issues such as data management may also be valuable.

Further inspection of the reports from the non CIS sites showed that a less enthusiastic but still favourable relationship was found between the nurses and the conventional 24 hour manual charts. The main difference between the reports from CIS and non CIS sites, was that the former could be identified as being more inclusive in its data management, whereas the 24 hour chart was more limited in its range, constrained to some extent by the content of its fixed printed format. However, it should be pointed out here that these charts can also be changed and updated. Therefore a similar axiomatic hypothesis can be proposed:

'a well designed 24 hour manual chart will be useful to nurses because it helps manage the large amount of patient data generated in critical care.'

The differences between the two statements therefore are in the degree of information management involved and are contingent on the charts being well designed and updated as practice develops. The differences within the data used to formulate the statement, relate to the extent of positive support of the CIS, and although a case has been made that the nurses showed preferential appraisal of this at the CIS site, this will be more closely scrutinised during the synthesis of the quantitative data. In summary, both the computerised and the non computerised sites identified that their repositories of patient data could be helpful to them. The next issue to be explored was whether this patient data management helped their nursing.

This link was less clearly defined. At the John Radcliffe, a number of nurses identified that the CIS eliminated the occurrence of paradoxical charting. With conventional systems, as the patient becomes more unstable there is less time for accurate recording of patient data, precisely when it is needed most (Kari 1988). Perhaps related to this, time management in general was also identified as an important factor. Therefore not only are advantages seen in terms of improved data management, an *indirect* advantage to care, but as in phase two, also in terms of saving time to *directly* enhance patient care. The specific

features of patient care enhanced by this saving were not identified in the responses with the clarity that was encountered in the earlier research, and this may be because of the brevity of replies which resulted from the questionnaire format. However, on inspection there were data (e.g. *'leaves more time to focus on the practical aspects of patient care'*, *'allows me more time to care for my patient'*) which supported the findings of the earlier respondents. Therefore the benefits could be included within the set of primary aims which were defined in phase one and developed in phase two. This discussion was used to propose the next axiomatic hypothesis:

'A properly implemented CIS will be useful to critical care nurses because it can provide extra time to deliver the nurses' primary aims.'

Thus far it has been suggested that within this phase of research, the benefits identified at the CIS site have been paralleled by the reports from the manual sites. However, this is not the case here. At the manual sites, there were no reports of time being saved by the charting systems, indeed there were comments made which suggested that the 24 hour chart was time consuming, and this provides a discrete difference between the computerised and non computerised sites.

In summary then, a case has been made for both the CIS and the conventional paper chart. It has been suggested that both were useful in managing patient data, although the computerised system has described more enthusiastically and was more wide ranging in the data it records. The major distinguishing criterion was the better time management afforded by the CIS. However, the paper chart undoubtedly remains cheap and may be open to further development. Therefore there may still be more value to be gained from this format in future. It is interesting to have proceeded so far in the research project and yet not have arrived at the overwhelming support of CIS as the exclusive way forward for data management suggested by previous authors (Lutheran Hospital 1991; Lenz and Metnitz 1995; Duce and Harris 1990). Fortunately there are further data from the questionnaires which can help differentiate between the systems.

Some weaknesses of both were reported. In particular, the feature identified as the *'only as good as'* syndrome was identified for all methods of data recording, although it could be described as being more common or even endemic amongst the CIS reports. This suggested that the CIS had many advantages within the design, but these were limited by the ways that the nurses used them. It was suggested within the synthesis of phase two that the nurses who resisted the CIS at Killingbeck did so by expression within their charter, a condition described as *'resistive compliance'* by Timmins and Millar (2002 p5). This may also be true here, the pattern of ill usage reported fits this proposal, except that really there was no other evidence to suggest that resistance was a feature. There were no clear statements of dislike or antagonism towards the CIS at all. It is possible that there was a distinct population of nurses who did resist the system and it is also possible that this population did not complete the questionnaire as an expression of their resistance. However, this is unlikely. Some nurses within the population, although enthusiastic, identified that they, on occasion, had accepted the default settings. A simpler and therefore more likely explanation again relates to time management. Critical care units are stressful and busy areas (Maloney and Bartz 1983; Lloyd Jones 1994; Norrie 1995). Even the most organised and motivated critical care nurse will on occasion be pressed for time and may do what is easiest and quickest, rather than that which is most accurate. Systems such as the CIS therefore are at risk of having inaccurate recordings made, if the default setting is itself an inaccurate representation of the patient's condition. It was suggested in phase one that a concern with CIS was that of losing the 'cognitive step', where the nurses considered and edited the data before entry, eliminating artefact and unrepresentative recordings. This step was seen as being valuable in terms of producing good quality patient data. This suggests that at both sites nurses, at times, did not use their data recording optimally. On these occasions the cognitive step was apparently not applied. This means that data recording is not a simple objective process as has been hitherto suggested within the literature (Imhof 1992; Clemmer and Gardner 1992). Therefore when interpreting patient data it would be wise to acknowledge the

subjective nature of the materials. However, this discussion is less firmly based upon the research findings and analyses, therefore it will be formalised, using the definition on page 149 as an axiomatic memorandum rather than a hypothesis:

> *'All patient records will have a subjective element to them: systems which encourage the inclusion of a cognitive step will result in more relevant patient data recording.'*

It is not within the scope of this project to identify ways in which the cognitive step can be more successfully incorporated within CIS, but it is hoped that identification of this issue may be a useful and innovative finding. Certainly within the conventional chart more use would be made of the cognitive step and it could be argued that production of a simpler more representative set of data may be useful 'in the field' (Clemmer & Gardner 1992). However even here, where nurses had to physically write down their recordings, there were still some, albeit fewer, references to the '*as good as*' phenomenon.

The last issue to be identified from the open ended questions was that of care planning. At John Radcliffe it may be remembered that the CareVue system care planning facility was not used. All three sites used essentially similar pre-printed care plans which were modified and updated by hand. The planning of care is an integral part of nursing (UKCC 1993; Roper at al 1994). It is unfortunate then that at all three sites, there was basically a dearth of any positive comments to be made about the care planning. Given that it was evaluated poorly at all three sites, in both the qualitative and to a lesser extent, in the quantitative strands of investigation, there is clearly room for improvement. At the manual sites this might be through a thorough overhaul of the documentation. A number of the nurses at John Radcliffe asked that the care planning should be carried out using the CIS. This therefore is a suggestion for further development in both practice and research and a clear statement of support for CIS in general and CareVue in particular.

In summary, this section has examined the findings of the open ended questions from the Likert questionnaire and attempted to synthesise theory using both the literature and the previous research methods. Some problems have

been identified from the use of CareVue at John Radcliffe, which has been taken as an example of a CIS in practice. However, having discussed these problems, it should be reiterated that the main theme which arose from the transcripts was one of overwhelming support for the system. It was evaluated very highly by the nurses, to the extent that they wished it to spread into more aspects of their nursing, specifically into the care planning. However, the 24 hour chart was also shown to be useful, and so CIS may not be an exclusive panacea for data management. At the manual site many negative comments were also made about the ancillary paperwork and so there is certainly room for review and improvement of this. The written record is therefore not purely of historic interest only within critical care, rather it is a live issue worthy of further development. However the CIS has been shown to be supported very positively by the nurses who used it. The final set of data, the Likert questionnaire will be used to examine this more closely.

Contribution of the statistical evaluation

Perhaps the most striking finding to arise from the quantitative data was that the CIS was identified as being significantly more favourable in terms of data management and recording than the manual systems. However, at the risk of repetition, the 24 hour chart was also found to be at least satisfactory at both sites. Fielding and Fielding (1986) caution that it cannot be taken for granted that the strengths of one method of inquiry will necessarily make up for the weaknesses of another and that therefore triangulation will not necessarily result in a stronger case. However these similarities are so striking, so evident and so consistent, that the case here is strong. A CIS can work well for nurses, and this was identified at a number of levels within the quantitative data. The 24 hour chart can also work well, but the support was not so dramatic. There was no disparity between findings from either method.

Within the literature review, a number of reports were found which indicated that there might be a relationship between age and seniority of nurses and their attitudes towards computerised systems (Brodt and Stronge 1986; Lowry 1994; Bongartz 1998). It was concluded however that in effect, most of these findings

cancelled each other out, the only consistent finding was that nurses who had used systems were less enthusiastic than those who had not. This third phase of research can add to this discussion. Statistical analysis confirms that there was no significant relationship between age or clinical grading and satisfaction with methods of data recording. However, those who did use a computerised system evidently were more pleased with it than those who used the manual system, in contradiction to the findings identified above. This may be an anomalous result, but it may also be a comment on the quality of CareVue in particular, as a well designed system, or it may be a reflection on the advanced nature of contemporary CIS systems.

Other issues can be discovered within the data. From the analysis of the open ended questions, it was suggested that two themes had been identified as being valuable to the nurses. These were help in the achievement of their primary aims of delivering patient care and help in data management. The factor analysis of the Likert scale however identified six factors within the data. One of these was much larger than the others and scrutiny of its components suggests that this may represent the 'primary aims' component. Unfortunately the analysis could not categorise the other five factors. However, it does give some support to the argument that what nurses desire from a CIS relates to more than one theoretical dimension. It is also congruent with the argument derived from phase two, that in addition to the activities of Norrie's (1997b) category of direct nursing care, other aspects of data management, so that you *'know what is going on with the patient'* (in Simon's words), are important for critical care nurses

The final source for comparison used the data relating to care planning. From the open ended questions it was found that all of the respondents were displeased with their care planning system. By comparison, the Likert data was less emphatic. The quantitative data showed that there was no significant difference between the three sites, but the responses hovered around a value equating with 'satisfactory.' Therefore, the open ended questions produced a more vivid response in this context, which perhaps is accordant with the nature of qualitative data. However as qualitative data it would be wrong to equate this with

the extent of dissatisfaction. Instead, the statistical data showed that the care planning at all three sites was significantly less well evaluated than the other aspects of data management. Therefore although emphases within the picture gained from the two sets of data differed, the messages remained the same: both the CIS and the 24 hour charts worked well, the CIS rather better than the manual charts. By comparison however, the care planning was not so well evaluated, at any of the three sites.

As an experience in learning how to triangulate different sources of data, this was a rewarding experience. Both Fielding and Fielding (1986) and Silverman (2000; 2001) suggested that triangulation is not as straightforward as has been portrayed by some authors. However in this case, the results from the quantitative strand have been extremely harmonious with those from all three qualitative strands. There were no instances where a dissonant gap could be found between the sets of data. The qualitative strands supported the quantitative strand quite elegantly. The most straightforward explanation is that the triangulation worked!

Conclusion

In summary therefore, this phase of research does have strengths. It uses different sources of data and produced an effective set of findings, supported by triangulation both between and within methods (Denzin 1989; Yin 1994). Therefore validity does seem to have been supported within the research. Given that this investigation was intended to have been the one where the findings of phases one and two were 'proved' (or not), reliability has been shown to be less than straightforward. More specifically, although the internal reliability can be considered to be satisfactory, the external reliability is less strong.

However these findings are not surprising, and do not negate the value of the research. This is for two reason. Firstly, the design is an amended form of case study, and therefore its findings were never purported to be widely applicable without consideration and interpretation. All it can be expected to do is analyse the case which was studied. This it did.

Secondly, the whole research project was formulated within an interpretivist *milieu*, and so again was never intended to be used indiscriminately to predict future cases. Instead, it can be convincingly argued that some notable goals were achieved. Firstly, it used the findings of the first two phases of research and presented them to a broader audience, to see if the findings 'made sense' within the critical care environment. They clearly did. Secondly it was found that within this group of cases the CIS implementation could produce a recording and data management system which could be more satisfactory to the nurses who used it than conventional charting. Again, it clearly did this. This represents a new contribution to knowledge.

Concluding analysis

It has been suggested that the main criterion for any research project is for it to make an original contribution to knowledge (Phillips and Pugh 1994; Holloway and Walker 2000). This concluding analysis therefore will provide the test of the worthiness of the set of the three phases of research, but before this can be achieved it is necessary to review the origination and substance of the findings thus far, so that the provenance of any innovative findings can be assured.

A suitable place to start might be the choice of theoretical framework which was used firstly to develop the strategies within the project and secondly underpinned the research as it unfolded. Some repetition of discussion may result from this, but the recapitulation of old themes may be timely in giving context to the analysis, not the least perhaps in helping to delineate its limitations.

An early decision was to choose an interpretivist paradigm, guided by the preferences of much of the published work from within the social sciences (Silverman 1993; Clough and Nutbrown 2002). It might be worth considering at this point whether this has proven to be a good choice. One interpretation of the interpretivist paradigm is that it does not assume that there is a single objective reality which can be measured, rather there are instances which can be described and analysed to generate new ideas and theories (Glaser and Strauss 1967; May 1997). This was supported by the use of an adapted case study framework. A case study has no pretension of proving that a phenomenon is universal, instead it explores one example, again to generate new ideas and theories (Yin 1994; Denscombe 1998). Therefore, whatever is derived from this project will be bounded by these considerations. However although these are limitations, they are not necessarily weaknesses. The purpose of any research project is whether or not it answers its originating research questions, and therefore this will be the objective criterion to judge its success or failure.

Two research questions were set: firstly, what do critical care nurses require from a CIS, and secondly, is it possible for a system to meet these needs?

With regards to the first question, the use of a coherent and strategic course of research, involving principally the first two phases of research, has allowed these requirements to have been addressed in a manner which can be shown to be reasonably valid. This was an inductive process. It has shown that the nurses want CIS to support their primary aims and are likely to consider favourably any form of technology which might help them achieve these. The second question, which dealt with examining the practical application of CIS has also been examined, principally in the third phase, which was deductive in nature, with additional material supplied from phase two. In this instance the case study format is very evident, therefore all this can reasonably show is whether one example of a CIS could meet the needs of one particular group of nurses. This has shown that it is indeed possible for a CIS to meet these needs, one such system is currently in use at the John Radcliffe Hospital Intensive Care Unit, in Oxford, England. Thus the overall structure of the project, moving from inductive through to deductive was met.

This represents a modest but important contribution to knowledge, limited by the case study structure. Silverman however (2000) has suggested that well structured qualitative research can possess authenticity and may have broader applicability beyond the case. For example the UK government has set out an ambitious agenda for implementing electronic patient records before 2005 (DOH 1998; Brennan 2000). Clearly nurses will be directly involved with this initiative, both in the electronic patient record (covering incidents requiring treatment) and the electronic health record (a longitudinal 'cradle to grave' record). It can be suggested that what happens with CIS may represent a microcosm, or at least one facet of the broader implementation of IT. More specifically, it can be suggested that the specific elements of theory generated as hypotheses and memoranda may be applicable in different IT settings, wherever nurses are major participants. This means that the case study framework, although a limitation, still provides potentially important insight into what makes a system well received by nurses which may be of wider use. For example, it has been suggested that as a preliminary to computerisation, it might be effective to initially review and develop existing paper documentation. This suggestion appears to be applicable to a variety of clinical settings.

This discussion suggests that there is some evidence that the paradigm and frameworks chosen to explore the research questions were fit for purpose. In addition to these central findings, other more wide ranging aspects of theory have been identified. For example, within the literature review, a number of intellectual challenges were identified which were candidates to support the exploration of the data from the respective phases of research. These were addressed within the narrative thread in the sequential syntheses. What was produced from this formal process had three main components. Some of the challenges were found to be readily identifiable within the data. Some of them were not. Finally, some were found which had not been predicted at all by the literature review.

This section will look at all three of these, before a more formal review of the theory identified during the previous syntheses (i.e. what was discovered). This is because the production of theory is undoubtedly the most stringent challenge, and must therefore come last, when all other potential contributors have been evaluated to ascertain their value. The first category to be discussed is those challenges which were identified during the literature review, but which were not discovered from the data.

Applying Occam's razor

Gender related issues were identified as being potentially important issues, both as a generic statement related to power and dominance and more specifically in the relationship between a predominantly female workforce and technology (Pizurky et al 1987; Trauth 2002).

These issues really cannot be directly identified anywhere within the data, they are noteworthy for their absence. It is true that resistance, both overt and covert, were present, but there is no evidence to suggest that they were linked to gender related issues at all. Similarly, the dominance of medical staff over nurses (Stein 1967; Miers 2000; Timmons and Tredoux 2000) was identified as a potentially coercive force, but again there was no evidence from the data that this was influential. However, it could be argued that the absence of these issues is not in itself sufficient to discredit them as influences. Implicitly or indirectly, they may have importance. For example, Osborne (1991) and Miers (2000) suggested that by focussing on caring, nurses exhibited some of the characteristics of an oppressed group. Indeed, throughout the interviews at

both sites the experience of caring, as shown by the identification of the primary aims, was a universal phenomenon which was highly valued by the respondents. In support of this argument it could be suggested that because issues such as using the CIS to develop self or professional development were not really identified, this showed that the nurses had indeed internalised their subordinate status within the clinical area. This might be true were there not a simpler line of argument to describe the phenomena identified from the data, which refutes the idea of nurses functioning as a repressed group.

To demonstrate this, Occam's razor will be used. It is a philosophical tool, also called the principle of parsimony. It is a logical principle attributed to the mediaeval philosopher William of Occam. He stated that in any debate 'entities should not be multiplied unnecessarily' (*pluralitas non est ponenda sine neccesitate*). This principle states that one should not make more assumptions than the minimum needed. It advises us to choose the simplest one from a set of otherwise equivalent models of a given phenomenon. In any discussion, application of Occam's razor helps us to shave off those concepts, variables or constructs that are not really needed to explain the phenomenon. By doing this, the development of concepts will become easier, and there is less chance of introducing inconsistencies, ambiguities and redundancies (Thorburn 1968; Hyman and Walsh 1973). Therefore the non appearance of gender issues in the transcripts and analysis would qualify them as necessary entities, only if they allowed the simplest explanation of the phenomena encountered. However, there is an analysis which accounts perfectly well for what was discovered and which has fewer entities.

The research shows that the relationship between all three sets of critical care nurses and technology is actually quite clear. The simplest explanation is that they are willing to use a CIS or CAIT or indeed almost any form of technology imaginable, as a tool to further their nursing goals. This position ties in very clearly with the patient centered professional values identified by Cody (1998) and Hardy (2002). This position is satisfying on a number of levels. Firstly, this is not a new suggestion. The earlier researchers in this field using quantitative tools, including Brodt and Stronge (1996), Bongartz (1988) and Large (1994) similarly found that nurses were positively disposed to using computers, again in order to pursue their nursing goals. Secondly, within this

project, nurses have been described as pragmatists, a view which can be readily identified from the data, particularly the qualitative components. Pragmatists will readily utilise whichever tools are available to help them achieve their goals (Fairman and D'Antonio 1999). Thirdly, critical care nurses were identified as high achievers and amongst the most empowered of nurses (Hudak 1994; Norrie 1995). Again, this has been clearly echoed by the data from the first two phases of research, where no evidence of coercion was found. Indeed, the opposite could readily be identified, nurses who were quite combative and assertive within their roles. Despite this, the nurses were actually quite conservative, they did not try to renegotiate their licence or charter or position with the medical team or within the organisation, but they were prepared to be flexible. This can help explain why other issues such as the role of personality (Currie and Brown 1997) did not surface as significant factors.

Nurses therefore wish to develop their patient care. Exactly how they envisage a CIS doing this can also be explored from the findings, and in line with the use of Occam's razor, this can be done using those entities which *were* found to be present within the data. The first of these has been discussed as the 'two language' debate, one belonging to the technocrats who develop and implement the systems and one to the nurses who use them. There appeared to be a gulf between the two groups which was of service to neither. Without common ground, the two cannot effectively communicate (Garmer 2002). This predicts that with the *status quo*, the development, implementation and use of the systems will be unnecessarily challenging and lacking in harmony. However, there is some evidence to suggest that the concept of two languages is perhaps too simplistic. From within phase two and the qualitative component of phase three, the nurses did use terms from the lexicon of the technocrats. For example observations were made about the quality and quantity of the data accessed. This shows that the two languages are not discrete. Perhaps they could more accurately be described as 'dialects', which gives a more positive and empowering perspective on those wishing to develop the common ground between the groups. This discussion is closely allied to resistance.

Resistance to computerisation was reported by a number of authors (Dowling 1980; Gibson and Rose 1986; Timmins and Millar 2002). Resistance is associated with attitudes (Bongartz 1998) yet the researchers who used the tool of Stronge and Brodt (1995), including Brodt and Stronge (1986), Bongartz (1998), and Scarpa et al (1992) as well as the researchers who used other tools such as those used by Large (1994) and Lowry (1994) all found that nurses were generally positively predisposed to computerised systems, especially when they had not previously used them within the clinical setting. This gave rise to the idea of the *tabula rasa*, suggesting that the nurses were willing to use these systems, but only if their needs were met. In fact, resistance *was* found, as exemplified by Edwina 'the saboteur' and the phenomenon of *'only as good as'* from phase three. This disclosed covert resistance, expressed in terms of the nurses' charter, which suggested that the CIS at John Radcliffe, although largely positively assessed, was not addressing all of the nurses needs. The connection between the 'two language' debate above is of course that for the nurses' *tabula rasa* to be written upon favourably, it must be done in the nurses own dialect.

The *tabula rasa* may be a useful construct for those who wish to explore the field of attitudes, but in this project it will not be developed further. It has been useful in helping to analyse some of the phenomena discovered within this project, but although it remains an interesting concept, it is not sufficiently applied to add to further analysis. Its legacy lies in suggesting that whoever implements CIS needs to be aware of the nurses' desired outcomes for these systems and should be prepared to adopt these values.

These theoretical discussions lead on to the final contribution of this section. The literature review was both helpful and necessary to develop theoretical sensitivity for the project (Glaser 1978). However it did not prepare the researcher for the impact of the main body of the findings, especially in phases one and two. Extensive reading in the methodology of qualitative methodology prepares the researcher to be sensitive and subtle in the interpretation of interviews (and other methods of data collection) so that reflexivity is ideally avoided, or at least acknowledged (Hammersley 1998). This theme was taken up in the discussion of dimensionality (Trochim 2000), suggesting that within a phenomenon there could be different quantities or

trends. However, as a broad statement, what transpired, (especially in phases one and two) was remarkably modest in its dimensionality, in that the nurses were very clear indeed as to what they wanted from their CIS. In summary, anything that would help them to deliver better quality patient care would be seen as desirable, and this is the common link between the two languages debate, the *tabula rasa* and the dimensionality discussion. It is only in phase three (and to a lesser extent phase two) that there is development of a second dimension of more technically orientated data management, related to the dialect of the technocrat. To define the nurses' goals the term 'primary aims' was introduced, modified and refined throughout the project, until in its final incarnation in phase three, it represented a culmination, and for the purposes of this project, definitive description of the goals of the nurses.

In summary, the primary aims contained two main elements. Firstly, it included all the activities described in Norrie's (1997b p29) categorisation of direct nursing care. Secondly, it contained the ability to assess, display and interpret the patient data required by the nurses. It is proposed that this definition is an important consideration for the implementers of a wide variety of technology including CIS and CAIT.

One final contribution from the literature review should be considered before moving on. It was suggested that an alternative to a scientific or positivist investigation of the impact of these systems on nurses was required if meaningful results were to be obtained. Towards this end an interpretivist framework was discussed, where monolithic theories could not be used to describe humanistic interactions, which make up the main body of nursing activities (Fox 1993). However, the definition of the primary aims seems to be contrary to this line of argument: they could be interpreted as representing a monolith themselves. Indeed the unanimity of the sources within the research is in itself suspect, because this suggests that contrary to all the previous discussions, the use of a CIS actually is susceptible to analysis within a positivist paradigm. However this can be refuted. This conclusion is based upon two arguments. It may be recalled that when considering the contributions that different research frameworks could make to the project, the role of ethnography was considered, and it was shown that critical care nurses operated under their own cultural rules. What can be suggested from

the research data and this viewpoint is that the primary aims themselves represent a cultural aspiration. The respondents may actually be speaking not as individuals, but as critical care nurses with their own description of social context (Hammersley and Atkinson 1995). What this means in practice is that the primary aims may represent a shared value. However, the ways in which the primary aims can be achieved will be extremely varied, because by definition it will be dependant upon what happens with the individual nurse at the individual bedside, caring for the individual patient. In other words, although the primary aims may give guidance as to the wishes of the nurses, it is only through a summation of the interactions of the nurses, the clinical environment and their clients that it can be judged whether these are met. By definition therefore this will be an individualised, transactional process (Meleis 1985). Thus the interpretivist framework remains an attractive proposition: there are no sweeping assumptions to be made about bedside practice, except in the broader goals which the nurses wish to gain from the uses of a CIS. However, perhaps more importantly and certainly more pragmatically, rather than adopting a rigid ideological viewpoint with which to investigate the interactions between nurses and CIS, it can be argued that it is more important to identify that future research must be focused at this interface. It is suggested therefore, that only by painstaking investigation of the myriad phenomena which occur at this level, can a meaningful picture be reliably established.

Assessment of the theories and memoranda produced within the project

During the synthesis sections of each phase of research, theoretical hypotheses and memoranda were generated. The distinction between the two was somewhat arbitrary. Both sets could possibly contribute to the generation of theory. The hypotheses were broadly taken from the main flow of data within the research and, using the same metaphor, the memoranda originated from side currents and were therefore more tentative in nature. One of the postulated strengths of the narrative thread was that the research phases did not stand alone, but were part of a process. This is true also of their findings and so this section will aim to appraise and contrast the theoretical candidates to finally generate robust theory. Thus the production of theory here is a

transparent process, which will add to both its validity and reliability (Silverman 1993; Yin 1994).

Table 63 shows a summary of the hypotheses and memoranda identified in the phases of the research. What emerges from inspection of these statements is that they fall within related groupings. This section will identify these groupings and then analyse the groups to arrive at, it is intended, robust theory.

Group one

The acceptance of CAIT by critical care nurses is not a once only or unique event, but can be built up by a number of favourable encounters which are defined in terms of the nurses' primary aims.

During the implementation of CIS there will be a critical point when nurses re-shape their practice. If this can be done to enhance the achievement of their primary aims, acceptance will be promoted.

This initial pairing looks at issues relevant to the implementation of CIS and other aspects of CAIT. In some ways, this is the most speculative of the theory generated, in that it addresses issues which arose from data but were not specifically addressed by the research. Exploration of the change process was never intended as a component of answering the research questions. These could therefore be described as 'incidental' findings, but that does not denigrate their significance.

Both statements look at what happens during the implementation of computerised systems. At first glance there is a tension between these two statements. The first one suggests that nurse acceptance can be built up by a number of positive events, the major criterion being whether the nurses' primary aims are promoted, whereas the second suggests a single or number of critical incidents during the implementation period will be influential. Given that the first statement was generated as a hypothesis, it would be logical to take it as the starting point for the analysis. There is of course common ground between the two. Taken together, the statements suggest that during the implementation of a system, achievement of the primary aims remains

Table 63: Summary of theories and memoranda identified from the three phases of research

Phase	Hypothesis or memorandum	Content
1	H	Critical care nurses will support the use of CAIT if it allows them to deliver better quality direct nursing care.
1	H	The acceptance of CAIT by critical care nurses is not a once only or unique event, but can be built up by a number of favourable encounters which are defined in terms of the nurses' primary aims.
1	M	A thorough review and ordering of the paperwork within the unit can support a number of the nurses' primary aims
1	M	CIS implementation can support communication, primarily with medical staff, and thereby increase satisfaction within the nursing staff.
1	M	CIS can make the nurses more visible and powerful within the clinical area.
2	H	Properly implemented and supported CAIT can allow more time for critical nurses to deliver their primary aims of patient care
2	M	During the implementation of CIS there will be a critical point when nurses re-shape their practice. If this can be done to enhance the achievement of their primary aims, acceptance will be promoted.
2	M	If CIS do not explicitly support the primary aims of the nurses, resistance will occur exemplified by rejection of the specific features of the system related to nursing.
3	H	A properly implemented CIS will be useful to nurses because it manages the large amount of patient data generated in critical care.
3	H	A well designed 24 hour manual chart will be useful to nurses because it helps manage the large amount of patient data generated in critical care.
3	H	A properly implemented CIS will be useful to critical care nurses because it can provide extra time to deliver the nurses' primary aims.
3	M	All patient records will have a subjective element to them; systems which encourage the inclusion of a cognitive step will result in more relevant patient data recording.

pre-eminent. What is also shown is that acceptance is likely to be a continual process, within which incremental critical points exist, based upon ways in

which the nurses role is re-shaped and enhanced. What this means for anyone interested in implementing such a system is that there is a core element to the strategies which should be adopted to promote nurse acceptance, the achievement of the primary aims. Each change to the nurses' role which moves towards this may have a cumulative effect upon acceptance. The converse may also be true. This discussion logically suggests that it may be possible to lose a battle without necessarily losing the war, as long as (to extend the metaphor) the next step in the campaign is appropriately orientated. For example, reliability of data was identified from the interviews as being a major concern. If incorrect data are entered into a system and because of this inappropriate patient care ensues, it can be predicted that the nurses will be likely to become less acceptant. In order to offset this, what would then be required would be a specific example or incident, in which the nurses' role could be shown to be enhanced. The next grouping will be used to give examples of such roles.

Group two

CIS implementation can support communication, primarily with medical staff, and thereby increase satisfaction within the nursing staff.

A properly implemented CIS will be useful to nurses because it manages the large amount of patient data generated in critical care.

This grouping is based around communication issues, dealing with the acquisition of patient data to inform nursing practice, and the support of communication of this information within the larger multi-disciplinary team. The management of the large amounts of data within the critical care setting is a major issue which has been discussed at some length within the literature review. This discussion will not be repeated here, the novel contribution of these theoretical statements is that they show very clearly *how* a CIS can enhance the nurses' role within the team (Phillips 1993). By sound data management, the CIS can not only inform patient care (a valuable end in itself), but also make the nurses more powerful players within the critical care environment. Taken in conjunction with the discussion on role expansion

(UKCC 1992b), this could help in the formulation of exciting new ways in which critical care nurses could develop their professional activities. For example, within the current critical care literature, there is discussion of nurse led weaning of patients from ventilation (Price 2001). To do this requires an accessible and authoritative database which would include elements such as previous respiratory history, arterial blood gases and proposed interventions. For example Lowe et al (2001) identify a minimum of nine physiological factors to be considered in weaning from ventilation. Therefore any system which can help the control of patient data could facilitate this process and as the gatekeepers to this information thereby enhance the status of the nurse.

Role expansion such as this is also directly in line with the achievement of the primary aims, allowing the nurse to become more flexible and responsible in the delivery of their nursing care (UKCC 1992). Thus a direct line can be drawn between control of information, achievement of primary aims and the acceptance of CIS. This argument can be expanded. As Lowe et al (2001) point out, currently nurses' roles are expanding, but often the process is not officially sanctioned. For example, using the same example of nurse led weaning, conventionally this has been role of the medical staff. As was discussed previously, nurses and doctors have been described as playing role games with each other, where the nurses have made patient management decisions, but because of their perceived lower status have gone to great lengths to make it seem that the decisions were made by their medical colleagues (Stein 1967; Miers 2000). If the data which are used to inform these decisions are, through the use of a CIS, made overtly available to the bedside nurse, this will be a powerful tool for making the nurses responsible for acting upon it to develop such roles as weaning.

One further memorandum, which can be included in this grouping, cites that

CIS can make the nurses more visible and powerful within the clinical area

and this is a clear example of how the open accessibility of the information necessary to make clinical judgements can free nurses from their previously subservient roles. This will not only help to make the nurse-doctor game obsolete, a desirable goal in itself (Stein 1990), but will also help nursing

within critical care develop more autonomously and thus be more responsive to client needs.

Group three

Critical care nurses will support the use of CAIT if it allows them to deliver better quality direct nursing care.

Properly implemented and supported CAIT can allow more time for critical nurses to deliver their primary aims of patient care.

If CIS do not explicitly support the primary aims of the nurses, resistance will occur exemplified by rejection of the specific features of the system related to nursing.

A properly implemented CIS will be useful to critical care nurses because it can provide extra time to deliver the nurses' primary aims.

This group forms the central theme of the research data. All its components deal with the relationship between the primary aims of the nurses and their use of a CIS. The origination and refinement of the primary aims has been dealt with earlier in this chapter, therefore this discussion will not be repeated. What is new here is an exploration of the relationship between the primary aims and the acceptance of or resistance to CIS.

Firstly, the term CAIT was introduced to describe equipment used within the clinical area which was driven by computerised technology, examples could include ventilators and syringe drivers. This was useful in the phase one and may be useful for further research, but in terms of this research project, because CAIT does not directly refer to the research questions, the term will not be used further. What the first two statements do show is that there is a direct relationship between the nurses' use of any form of equipment involving IT and achievement of the primary aims. This is expressed in two related but distinct forms. Firstly, in terms of quality. Within the first phase of research, improved quality of care was repeatedly identified as a desirable issue in any implementation. This thread was also picked up in the other two phases, and

so constitutes a major theme. However, the second issue, that of saving time, although also emerging within the first phase, was more pronounced in the second and third (notably in the open ended questions on the phase three questionnaire). To some extent, emphasis has to be placed upon the time management issue, because firstly, this was represented by two theoretical hypotheses rather than memoranda and secondly, it was reported by a number of nurses who were actually using a CIS at the time of the research, or had used one previously. This is in contrast with the nurses in phase one, who to some extent were merely speculating upon ways in which a CIS could enhance their nursing. What needs to be included at this stage is the conditionality of the statements which might raise them to the status of axiomatic theory. These positive outcomes can only be expected where the CIS has been carefully implemented and maintained, and so the implementation phase of a CIS must form the focus of further research into the use of these systems. Without this knowledge, the theory statements struggle to become axiomatic theory and could be described as remaining in the state of a conceptual frame work (according to Bowling's (1997) classification). Despite this limitation it can be strongly argued that these findings represent important theory for researchers wishing to investigate the impact of CAIT or CIS on critical care nurses, indeed to have clearly identified the orientation of the next stage of research is in itself a useful contribution to knowledge.

Group four

A thorough review and ordering of the paperwork within the unit can support a number of the nurses' primary aims.

A well designed 24 hour manual chart will be useful to nurses because it helps manage the large amount of patient data generated in critical care.

It is easy to get excited by the application of expensive technology to clinical problems (Firth 1985), and indeed even casual reading of the literature suggests that this is a common phenomenon. Although much has been made of the shortcomings of manual record keeping (Avila and Shabot 1988;

Millholland 1988), it would be unwise to dismiss the paper record summarily. Critical care nurses have been shown to be ambitious and assertive practitioners (Norrie 1995). It is unlikely that they would be satisfied with a system of data recording which did not meet at least a number of their requirements. Indeed, the paper record has been developed and refined over a period of at least 40 years and has managed during this time to assist in patient care. These two theoretical statements show clearly that there is still room for further refinement. This is especially true when considering the ancillary paperwork (i.e. the 'other' paperwork, excluding the main observation charts), which was generally described in phase one as being a mess. This suggests that before paying large amounts of money for unproven CIS systems, such as happened at Leicester Royal Infirmary, an almost infinitesimally more modest outlay spent on the further refinement of existing paperwork could result in significant improvement, in both achievement of the primary aims and in data recording and interpretation, within the critical care environment: a sobering thought for computer enthusiasts.

Group five

All patient records will have a subjective element to them; systems which encourage the inclusion of a cognitive step will result in more relevant patient data recording.

This final grouping contains one item only. However, in some ways it is the most radical and perhaps the most original of all the findings. As was discussed in the literature review, much of the research on the implementation of CIS has been completed within the medical domain. Thus authors such as Imhoff (1992), Clemmer and Gardener (1992) and to a lesser extent the nurses who published within the field such as Millholland (1988), Cerne (1989) and Norrie and Blackwell (2000), lay stress on accurate data being a prerequisite for high quality patient care. What is implicit within these views is the belief that the parameters which can be stored on a CIS database are absolute, that is they belong within a scientific or positivist paradigm. What this research project has shown clearly, is that in fact a proportion of the data have a subjective element, where for example, the nurses have edited the

data to give what they feel is a 'truer' picture of the patients' condition. Equally data may be entered which are simply untrue, where nonsensical default settings have been selected. In other words, patient data are not a simulacrum of the patient, but belongs within the interpretivist paradigm, and should therefore be treated as such. Quite what such a consideration would mean for the world of medical quantitative data collection within critical care is beyond the focus of this research project. However it does at least suggest that unless great care is taken to incorporate this within experimental design, some data collection and analysis could be misleading, and this may be a previously undiagnosed limitation to this branch of research. It also has some implications for this project. What the memorandum suggests is that rather than being a weakness, this can contribute to the strength in the data collection. This works on two levels. Firstly, in what Lenz and Metnitz (1995) described as the 'actuality of the data', that is in addressing how well the data reflect the patient's condition. Using any monitoring system, artefact will occur and the recording of artefact will result in potentially misleading data. For example a patient may roll over and pull off an ECG lead. The computer may recognise this as a cardiac arrest situation and record data accordingly (Demeyer 1967). Therefore it is a strength of the subjective nature of the data recording that the nurses will then substitute less alarming and arguably more accurate (or at least more representative) data within the database. Secondly, the bedside nurses have significant expertise. Any system which encourages them to use what was described as a 'cognitive step' in data management, will allow the incorporation of this expertise to construct a more valid record. The weakness which was identified using CareVue was that it was too easy for a busy nurse to allow the default setting, no matter how inappropriate it might have been. Logically it might be considered better to have a blank value rather than a default, to paraphrase Anthony (2001), it is better to have no data than wrong data!

Contribution from the deductive data

A mixed method design was chosen for the project. The earlier qualitative elements were inductive and allowed the generation of theory. Within the final phase the quantitative tool allowed deductive inquiry. Not only did this give some theoretical completeness to the project (Tashakkori and Tedlie 1998), it

also gave an opportunity to assess the integrity of the earlier research phases, by presenting the findings from the earlier phases back to critical nurses within the clinical setting. Thus if the interviews and data collection from the first two measures had been coherent, what would result would be a tool which could distinguish between a clinical area which had data collection and management systems which were broadly supportive of nursing practice, or conversely hindered it. In addition, it was useful in addressing the second research question.

In fact, the comparisons were very clear. At the John Radcliffe hospital where CareVue was in use, the nurses reported statistically significant higher ratings of satisfaction, than at the conventional sites. This is an important finding and is, it is believed, unique. It means that there is evidence that nurses find that CIS can help nurses in delivering care. The statistical analysis provided further proof of the strength of the research procedures used. Firstly, the alpha analysis showed that the questionnaire was internally reliable, supporting the interviewing and data collection methods used. Secondly the correlative statistics showed that extraneous variables such as clinical grading and length of experience did not effect the results, supporting its general robustness in isolating factors which are relevant to data management and handling.

Perhaps the main finding from the qualitative work was the definition of the primary aims. The factor analysis identified six factors from the data set of interest. One of these which was much larger than the other and was representative of the majority of items within the questionnaire. Given the source of the items included within the Likert questionnaire, it is therefore reasonable to identify this as relating to the nurses' primary aims. Unfortunately, the analysis was not capable of characterising the other factors. However, the identification of a questionnaire which can explore the primary aims of nurses with regard to data management and handling is in itself a useful contribution to research. Indeed, the questionnaire may prove to be a useful tool. For example it would be fairly straightforward to use in a pre and post CIS implementation study. As a tool it is concise and easy to use. It does not require observations or training amongst participants. The one caveat which should be included in its use, is that it should not be viewed in

isolation, but as part of a larger programme of research, which could use both qualitative and further quantitative elements.

Limitations of the research and suggestions for further investigations

This thesis is composed of three phases of research, the theoretical findings of which have been combined in the concluding analysis. The limitations of each phase will now be discussed to determine whether they weaken aspects of the theory generated.

Limitations of phase one

There are a number of methodological weaknesses. To recapitulate briefly, although intended to be based upon a grounded theory framework, compromises were made as part of the agreement with the clinical area to allow access to the research site. In particular, rather than allowing the kinds of open question which would have allowed a free generation of responses from the candidates, the questions were to a greater or lesser extent focused directly on the CIS implementation. Given these limitations, it is reasonable to ask whether this research can really be described as being based upon grounded theory at all.

In defence of this first phase, it could be argued that the research is still valid, even if it does deviate from a purist grounded theory line. The rift between Glaser and Strauss, the founders of grounded theory has already been discussed, and was characterised as a debate between theorists (Glaser) and pragmatists (Strauss). It is not the purpose of this discussion to explore the rights and wrongs of the two camps. However, Glaser (1992) does make an interesting point. He states that because the procedures of *'Basics of Qualitative Research'* (1990) rely on forcing the data, they do not lead to poor grounded theory, they lead instead to a totally different method altogether, which Glaser (1992) terms *'full conceptual description'* (p 122-124). Being influenced by Strauss and Corbin (1990), this phase of research fulfils many of these criteria. Therefore, what has originated from this research is likely to be shallow, and this may well be the case. However shallow is not the same as being wrong or false. If this research phase were the only one, it could be concluded that a shallow research project would result. Fortunately however, it is not alone and was succeeded by two further investigations.

It remains unique (it is believed) in allowing a group of nurses to put forward their own thoughts, fears and aspirations concerning the use of CIS within the critical care environment. In addition the description has, it can be argued, been to some extent elevated by consistent application of the theory identified within the literature review.

It is customary at this point to consider the issues of reliability and validity. It has been suggested that reliability is a criterion more applicable to positivist work, which is based upon the assumption that there is a single non contextual phenomenon which can be accurately and repeatedly measured (Marshall and Rossman 1989). To apply this criterion to a research project which is, by design, highly contextualised within a changing clinical setting may be undesirable, as it would be contrary to an interpretivist viewpoint. Silverman (2001) to some extent agrees with this, but makes the point that for acceptance of its findings, qualitative research must show itself to have applicability in the world and to be truthful. He suggests that this can be achieved by the use of low inference descriptors, whereby every step of the research process can be traced back and if necessary repeated. Using this suggestion, the process of interview, recording and transcription can reasonably be justified as being of low inference, in that they could be repeated and presumably a set of data of a similar although not identical nature would be yielded. Silverman (2001) however suggests that it is in the analysis that inferential assumptions can be included as this is a less transparent procedure. Using this model, two pieces of evidence would tend to support reliability. Firstly, as mentioned in the methods section, an independent analysis was carried out by an appropriately qualified nurse researcher and findings were compared and adjusted where both parties felt it was necessary. Secondly, a quite rigorous process of data identification, labelling and reduction was used, which could be independently verified from the interview texts. As a final point, it should be mentioned that the research used the largest sample that was feasible within the resource and skill constraints of the project and contained staff who were representative of all the grades who would use the CIS. Indeed if a large sample size is one feature suggestive of increased reliability in the research design (Bowling 1997; Denscombe 1998), then it could be argued that this feature was

pursued almost to beyond its limits. Certainly a larger size would have been unwieldy and progressively harder to analyse as the sample size increased. Perhaps by good luck rather than skilled judgement, something approximating to optimum size was reached, where the sample was large enough to promote a representative sample size, but the data produced were not too overwhelming for a concise or accurate analysis. Thus if reliability is seen as being an important quality of the work, a case can be made that it has been addressed.

Validity is perhaps a more important criterion. Here some significant flaws can be identified. Firstly, as noted in chapter five, the researcher was inexperienced in undertaking interviews and this could result in reflexivity which could bias responses. However, the use of the interview schedule was helpful in maintaining transparency and it can be argued that there is no evidence from the data analysis of a difference between the theoretical elements identified at the beginning of the set of interviews, where interview experience was severely limited and those identified at the end.

Secondly, within approximately half the interviews a senior member of staff was present and this represented a potentially significant source of bias. Indeed there is some evidence of bias present from this source, including the use of loaded questions ('you spend a lot of time on charting and writing on the chart and that kind of thing?'), which was noted by the independent analyst. In addition experience in interview techniques was limited for the primary researcher and essentially non existent in the senior nurses responsible for the implementation.

However, It could be argued that these factors are less significant, if the nature of the population is considered. Critical care nurses have been shown to be highly motivated and high achievers (Norrie 1995). They are a group of professionals whom, this work identifies, are highly motivated in achieving their goals of quality patient care. This suggests that they are not likely to be easily swayed by the presence of a senior member of staff. In support of this, no real difference of tone can be noted from the transcripts where there were one or two interviewers. Indeed some of the more critical attitudes were demonstrated when the senior member of staff (Irene Duncan) was present (see interview with staff nurse G, appendix 2).

Both Silverman (2001) and Denzin (1989) suggest that comparison through triangulation can support validity, although this is not necessarily a straightforward process. Some support has been illustrated when considering internal consistency within phase one. As identified earlier, a measure of method triangulation occurred within the interviews. What this means for the research project is that within each interview there was an opportunity to assess the same phenomenon more than once and from different perspectives. Therefore it may have been possible to arrive at conclusions which offered greater depth than if the respondents were able to discuss the phenomenon only once. Again, review of the interview transcripts does suggest that the findings are homogenous, because there are no obvious inconsistencies or major contradictions to be found. On the whole, the points which were made appear to be straightforward, consistent and simply expressed. This suggests that the accounts are truthful, a quality closely related to validity (Silverman 2001).

On an admittedly subjective account, the data and analysis 'feel' right. Using Glaser and Strauss' (1967) concept of theoretical sensitivity to explore this, the researcher can identify the ideas and attitudes expressed in the interviews and can follow these through the data manipulation to the generation of the theoretical statements. In support of this, although the data analysis has been described largely as a linear process, in fact it was a highly iterative one, with the data being repeatedly sampled on a number of occasions to reshape the ideas it produced. It can be argued that this in effect produced close quality control. However it is left to the other research phases to identify whether these findings can be supported and truly be identified as valid and indeed reliable.

Limitations of phase two

This research had some of the qualities of a grounded theory investigation. However, not all criteria for this were thoroughly satisfied. In particular theoretical sampling although present, was limited to an *ad hoc* examination of field notes between interviews, rather than being an integral part of the research planning.

However, if it is held that reliability is an issue within qualitative studies, some aspects of it have been achieved. Most facets have been clearly

described and could in principle be repeated (Silverman 2001). Casual inspection would suggest that one of the major limitations of reliability was the small size of the sample. However, this is not such a significant weakness within the interpretivist *milieu* in general and grounded theory in particular. It was never really intended that the sample could be used as a predictor for larger populations. Instead, because grounded theory is an inductive framework, it allows concepts and theories to emerge (Glaser and Strauss 1967). Rather the limitation here is that the sample size of four people means that this phase of the research stops prematurely, which will limit the quality of the theory identified, whereas in a full grounded theory exploration of a topic, data will be revisited until they are saturated, which will support both reliability and validity. Thus if viewed in isolation, the research is incomplete. However, it can be strongly argued that important data have been found and from this some potentially useful theory has been proposed.

In terms of the qualities of the interviews, less bias is likely to have been experienced in phase two than phase one. At no point were senior nurses involved, neither was there any organisational pressure placed upon interviewees. In addition, the researcher had gained experience, not only from conducting the earlier set of interviews, but also from identifying possible sources of bias within the earlier transcripts. Using the interviewees themselves to read and comment upon the transcript proved to be a valuable tactic and helped rectify a number of incorrect interpretations, especially of Edwina's contribution. Thus bias was minimised in the analysis.

Perhaps the final issue to be addressed is the nature of the data. The recollections of the respondents were quite old, and therefore might have become unreliable over time. However, they *were* consistent, suggesting internal reliability, both when compared with each other and when compared with phase one. In addition, the nurses themselves were quite clear in their recollections and not hesitant in identifying accurately features of their CIS.

In comparison with phase one, there is some rather more convincing evidence to support validity. The sample were not pressurised and there was no input from the nursing management. As the second phase of research it becomes possible to compare findings with the first, to allow triangulation. In

general, this was achieved quite harmoniously, and some categories (such as the definition of primary aims) became further refined.

Limitations of phase three

The open question data will be discussed first. Some limitations have already been identified. For example the brevity of the replies to the open ended questions was noted as a limitation to analysis. However, given the modest nature of the data, it can be argued that some very useful findings were generated.

Firstly the likelihood of question bias is avoided by the use of the three open ended questions which, in contrast with the interviews, are unchanging and allow complete transparency. However within the open ended questions one point that should be addressed is the relative nature of the comments. In order for a respondent to identify that a system of data management is quicker or better than another, does suggest exposure to and knowledge of both systems. However there was no evidence as to the quality or nature of previous exposures, so it was not clear what comparison was used by the respondents, or if, as seems likely from the disparate population of nurses, a wide number of individual comparisons were used. For example, as a cohort the respondents at John Radcliffe had a large proportion of highly experienced nurses (tables 54 and 55). It is reasonable to assume that they may have worked in other areas (as is common amongst the critical care community) where conventional paper charting was in use, or would be aware of other working arrangements outside their own environment. However the relative nature of the comments from the other two sites are less easy to clarify. To the knowledge of the researcher, only one nurse from either Glenfield or LGH had actual experience of using a CIS, so it is unclear whether the adjectival comments relate to an idealised system that the nurses can envisage, or other paperwork such as that used on wards. This perhaps represents a limitation to the validity of the research, which could be addressed in a questionnaire which explored previous experience more closely. Using the grounded theory methods of analysis adopted in phases one and two is also worthy of consideration. It could be argued that, because of the truncated nature of the replies, a simpler textual analysis technique might have been better. However, considerable experience of the technique of

applying open and then axial coding had been gained by this stage. Therefore the decision to use a familiar format can be defended since it allowed the application of this expertise. Again, the use of an independent analyst supported the validity of the findings.

As was discussed within the earlier phases, with qualitative data, the criterion of reliability is not always appropriate or provable. A similar case for reliability amongst the open ended questions can be made here as was made for phases one and two, therefore it will not be repeated.

However, with quantitative data reliability definitely is a major issue. (Bowling 1997; Denscombe 1998) This is an important issues for this project. Within the statistical analysis, consideration has already been given to internal reliability, in the discussion on Cronbach's alpha. However external reliability should also be addressed. One obvious weakness here lies with the sample. An inclusive sample of all the nurses was adopted at all three sites which removes the possibility of sampling error. This therefore was a design strength and built upon the strengths of using a questionnaire which can be widely disseminated. At first inspection it would seem that a sample size of over 100 respondents was respectable, as was supported by the power analysis (Anthony 1999; Black 1999). This equates to an overall response rate of 47% although this falls to 33% at the computerised site. Polit et al (2001) suggest that at least a 60% response is desirable, although they do state that lower response rates are common. These figures may therefore be acceptable. However, Oppenheim (1992) specifies that it is not the number of non respondents which counts, it is the possibility of bias. Clearly the responses at the John Radcliffe were most positive and it is worth considering if this might be due to bias within the sample. As a first position, this seems unlikely. Within the qualitative data, concerns were expressed about use of the default setting (the 'only as good as' phenomenon) and ward handover of patients. However it is possible, if unlikely, that a self selecting higher proportion of 'pro-CareVue' nurses completed the questionnaire in order to highlight their support for the system. This remains a limitation in the research design and could be addressed by encouraging a broader participation in the completion of questionnaires in future, perhaps by making it more concise or attractive and by using follow up reminders (Oppenheim 1992; Polit et al 2001).

The number of sites used is also a concern, as there is little evidence that the critical care units themselves were representative of either non computerised units or computerised units, in general. With respect to the non CIS sites, both qualitative and quantitative strands did suggest that the units were essentially similar, but the use of only two sampling units remains a weakness. With respect to the CIS site, the evidence suggesting that the John Radcliffe was more satisfactory than the other sites is relative in nature, which raises two further possibilities. Firstly, it is possible that if a conventional charting system were optimised, this gap could either be closed or eliminated, hence the weakness of using only two units as comparison is emphasised. Secondly, just because CareVue at John Radcliffe was rated more favourably, it does not necessarily mean that all CIS implementations will be so favourably evaluated. It is also possible that CareVue itself may be implemented in different, perhaps less successful ways. Indeed, as was discussed in an earlier chapter, during implementation a process of negotiation takes place, and similar technology may result in different working practices (Hughes 1971; Barley 1986; Curry and Brown 1997). This suggests again that the implementation at John Radcliffe, because of its success, might be a valuable opportunity or case to produce further research.

This leads on to the consideration of validity within the phase. It is possible that variables other than the CIS may account for the differences in the data from the John Radcliffe when compared with the non CIS sites. However, the questionnaire does appear to be robust. For example within the data analysis, extraneous variables such as experience and clinical grading were shown not to have significant effects on the data. In addition, the data relating to care planning showed that the questionnaire did not spuriously distinguish between the three sites. It can be suggested therefore that the questionnaire was able to appropriately discriminate between the data collected at the three sites within the expanded case study setting. In addition, it is also supported by triangulation with the open question data. However for it to be used confidently as a discriminator between CIS and non CIS sites, more sites should be studied.

Conclusions on the quality of the research in all three phases and recommendations

It is hoped that by using a transparent audit trail throughout the research project, that the validity of design has been addressed and proven. Reliability has also been considered. Within each phase of research, examination has been made of the options available to explore the research questions, and how these could most effectively be expedited. It has been suggested that through triangulation within and between the research phases, a synergy has resulted and the project, in its entirety, is a robust structure. However, even the best planned and implemented research project will have limitations, and this is no exception.

One of the most apparent limitations here was the nature of the data collected. In all three phases, the data were subjective. Nurses, in one guise or another, were asked to give their opinions on what they wanted from a CIS, or whether they felt a CIS met their needs. As research working within an interpretivist paradigm, this is probably acceptable (Silverman 2000). However, within the context of healthcare where large amounts of money may be spent based upon such research, it is worth considering whether a more empirical aspect should be included. For example it might be worth considering whether or not the nurses were telling the truth. There is some evidence that they were, in that very cohesive triangulation was found between and within the phases of the research project and this is suggestive of validity (Denzin 1989; Yin 1994). However the uniformity of the findings themselves might be considered a cause for concern. Popay et al (1998) suggested that a mark of quality in qualitative research is the discovery of a variety of findings rather than a small selection of themes, which would suggest a criticism of the methodology. However Hammersley (1987) suggested that an important proof of quality was the ability of the data to generate theory, which would tend to be supportive.

One way to reconcile these issues was touched upon in previous discussion but will be developed here. It was suggested that critical care nurses had developed their own subculture and cultural rules. The uniform nature of the data uncovered within the project could be interpreted as the expression of a cultural norm, which would explain the homogeneity of the

data. Evidence to support this can be found within the Code of Professional Conduct for Nurses (UKCC 1992a), which exhibits a similar emphasis on the primacy of patient care, and in the Scope of Professional Practice document (UKCC 1992b), where nurses' role expansion is justified in the delivery of more responsive patient care. Therefore the findings may not actually be representative of what an individual nurse at a given time wishes from a CIS. What is reflected however, is possibly more valuable. It can be suggested that the cultural aspirations of these groups of critical care nurses have been identified and these are likely to be functional within the working environment, where nurses interact as a coherent cultural entity. To borrow Silverman's (1997 p247) terminology, these findings are 'authentic', they are representative of a larger body of opinion and explain how the culture of critical care nurses will react within the clinical environment. Seen within the context of healthcare this therefore has produced a pragmatic set of findings which can realistically be used to inform the application of CIS.

Despite this argument, there is still a case to be considered for the inclusion of more empirical data to augment and substantiate the findings. One possible candidate was identified within the project. Norrie (1997b) put forward a five-fold categorisation of nursing activities and it was suggested that this had the benefit of being simple to use and had low resource implications. However, it was also shown to be too limiting in its content, because it did not include aspects of patient data assimilation, from which sound patient management could result. However, within Norrie's (1997b) scheme, there was a further category, that of patient assessment, which did include these attributes (p29). These two categories taken together are a remarkably close approximation to the primary aims. What is recommended for further research therefore is the inclusion of an observational study using Norrie's (1997b) research tool in a pre and post CIS implementation project, to provide some empirical evidence of the value of the CIS for the nurses, but with the specific injunction not to rely solely on the quantitative method, but to simultaneously run qualitative investigations, so that triangulation between these methodologically disparate sources can be considered. This could provide a valuable contribution to the debate on CIS implementation and suggests that it might be unwise to consign these reductionist research tools

to the margins of legitimate study, yet. Properly run, schemes such as the five-fold categorisation might still have a contribution to make.

A question mark also hangs over the implementation of CareVue at John Radcliffe. An investigation of the change process and the maintenance of standards and training lay outside the research questions originally identified. However in many ways, this represents the largest unidentified contribution to the debate of what makes CIS function successfully within the clinical area. Indeed, it has been suggested that this absence was the limiting factor to the quality of the theory produced by the project. In line with this argument it is suggested that this limits the applicability of the findings of the research project to other clinical areas. Fortunately it is an area of weakness which can easily be remedied. Before further research is carried out into the use of CIS, two modest research programmes are suggested. Firstly, a simple descriptive qualitative investigation is recommended at John Radcliffe to determine the roles of the main players in the use of CareVue, including the systems administrator, the nurses, their management and the medical staff. This would establish a benchmark of good practice, which could be highly influential for further research and implementations. Secondly a design for a pre and post implementation investigation was suggested above. Within this combined quantitative/ qualitative design, attention should additionally be focussed on the change process as the implementation unfolds, perhaps by using techniques such as those outlined by Currie and Brown (1997), who similarly charted the implementation of a computerised laboratory system. The major features of this investigation were discussed in chapter two and therefore will not be repeated here. The findings from either of these propositions would be important contributions and would significantly augment the findings from this research project.

The final consideration here is the methodological structure of the project. As an expanded form of case study, it can be argued that the ability to generalise to other care environments or to other CIS is not proven and should be approached with caution (Denscombe 1998). This is a limitation which was accepted in the design process as an acceptable cost to be paid, at the expense of contracting a coherent programme. However, this project by its expanded case study format has touched upon five different critical care

environments and found remarkably consistent data. This suggests that these findings may indeed be applicable outside the cases examined. This could be proposed through two dimensions. Firstly, although critical care environments do possess unique features, they also posses many commonalties with other acute hospital based environments (Maloney and Bartz 1983; Norrie 1995). Secondly, CareVue is only one system in current use and reviews of different CIS again reveal many commonalties (Lenz and Metnitz 1995). Therefore, although caution is necessary, it seems likely that a degree of applicability of these findings is warranted throughout both of these dimensions i.e. different care environments and different CIS.

The narrative thread

In an earlier discussion, it was suggested that the contribution of the narrative thread itself would be a topic for consideration and this is perhaps a good place to finish. It has proven to be valuable in giving structure to the project. Research within practice has been described as 'messy', an acknowledgement of the stresses and unpredictability of these environments (Atkinson 1994). Indeed some authors such as Mellor (2001) propose that these qualities can be advantageous to encourage novel strategies, as well as allowing serendipity to play a part. Whilst there may be truth in this, the narrative thread by contrast operates from a different pole, where structure and clarity are the main concerns. In particular, by formalising the relationship between theory and data it has given guidance to the project and has been especially useful in giving order to the generation of new theory, specifically in the synthesis sections and the concluding analysis. It can be suggested that this ties in closely with Silverman's (2001) idea of using low inference descriptors throughout the analysis process, so that the generation of data can be clearly mapped.

At first glance therefore, it seems to offer a lot to project design. However this then raises the issue of the authenticity of the resulting project. Within the introduction to phase three it was identified that one aim was to determine whether the findings from the first two phases worked, that is could be used in the 'real world' to produce meaningful results. This discussion is suggestive of the Ouroboros figure illustrated in the frontispiece. Similar diagrams date from at least 1600 BC, where in Egypt it symbolised the never ending cycle of life.

It has also been used in Greek, Hindu and Norse myth (McCoy 1997). It is included here because it can also be taken to symbolise the continual rebirth of the research cycle in general and the nature of the this project in particular. It suggests that the three phases of investigation taken together form a whole. It also suggests that they feed into each other, which is a strength, but also that they are self referential, which is a weakness. For example, it has been assumed throughout the project that the data from the first two phases could be tested in the third, and this testing would give some estimation of the value of the data. When this testing was undertaken, it did indeed seem to confirm the inductive findings. However, it could be argued that there is no direct connection outside the Ouroborous cycle to support the project. To clarify this, it could be suggested that the validation works both ways: the proof of the first two phases lies mainly in the findings of the third and the proof of the third phase lies mainly in the findings of the first two. However, just because the project provides data which can be elegantly explained does not prove the validity of the data. A more substantial basis for the analysis is needed. This is where the narrative has great value. One of its main constituents is the formal application of the findings from the literature review to the data from the research, in the three synthesis sections (diagram 5). This ensures that the project is linked within existing research and theory, and so the cycle although complete, is not insular, but is indeed 'grounded.' Thus its findings can be accepted as being part of, and supported by a larger tradition of study.

However it also has at least one limitation which became evident as the project proceeded. This was the repetition of discussion. If the final design of the narrative thread is considered (diagram 5), it can be seen that concepts from early analyses and syntheses are carried on into later discussions. This means that as the number of investigative phases increase, so too does the bulk of this conceptual information. It suggests that for the narrative thread to be efficient, it should be limited to a small number of phases of research, otherwise repetitive and unnecessary discussion will result, and the process will become unwieldy. In fact, the thread worked well in this project, but the discussions did need careful editing to avoid unproductive repetition, so it might be considered that three successive phases perhaps represents a maximal span for the structure. What this would mean for successive research

is that at a juncture where the generation of concepts becomes unwieldy, a line or a 'firewall' (to borrow from computing terminology) could be drawn under the research project, before the next phase of research was considered. This would then be the starting point for the next phase of research, again grounding the project within existing theory.

Thus utilising the narrative thread means that the research project is both completed and never complete. If this represents a paradox, it is at least an invigorating one. This too sets the scene for further work and is a good point on which to conclude this particular contribution

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